NASA/TM—2006–214603

Qualification Testing of Solid Rocket Booster Diagonal Strut Restraint Cable Assembly Part Number 10176–0031–102/103

T.W. Malone
Marshall Space Flight Center, Marshall Space Flight Center, Alabama

September 2006

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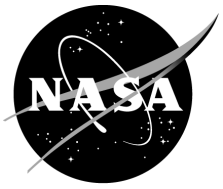

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National Aeronautics and
Space Administration

Marshall Space Flight Center • MSFC, Alabama 35812

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Acknowledgments

The author would like to acknowledge the assistance of several individuals who aided in the preparation of this document. James Hodo (Marshall Space Flight Center Mechanical Metallurgy & Corrosion Engineering Team/ED33) and Robert Bond (Morgan Research Corporation) conducted mechanical testing and provided test results and photographic documentation. Quality assurance and buy-off on test results were performed for NASA's Safety & Mission Assurance by Steve Presti (Hernandez Engineering, Inc.) and for United Space Alliance (USA) by Toni Andreoni (USA). Mark Hill (Space Shuttle Propulsion Office, Solid Rocket Booster Project/MP41) and Shane Canerday (USA) were instrumental in the coordination of the testing effort. Susan Hessler (Morgan Research Corporation) performed an editorial review of this document.

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ELV	elevated temperature
RT	room temperature
SRB	solid rocket booster
TM	Technical Memorandum
USA	United Space Alliance

TECHNICAL MEMORANDUM

QUALIFICATION TESTING OF SOLID ROCKET BOOSTER DIAGONAL STRUT RESTRAINT CABLE ASSEMBLY PART NUMBER 10176–0031–102/103

1. INTRODUCTION

This Technical Memorandum (TM) presents qualification test results for solid rocket booster (SRB) diagonal strut restraint cable assembly part no. 10176–0031–102/103. During flight, this assembly is exposed to a range of temperatures. MIL–W–83420 defines the breaking strength of the cable to be 798 kg (1,760 lb) at room temperature; however, it does not define cable strength at 669 °C (1,236 °F), the maximum temperature to which the cable is exposed during the first 2 min of flight.[1] The cable, which is able to be built from different corrosion-resistant steel alloys, may also vary in its chemical, physical, and mechanical properties at the tested temperatures.

Analysis of the cable at the tested temperature, when using the standard knockdown factors for untested requirements given in MSFC–HDBK–505, "Structural Strength Program Requirements," produced negative margins of safety.[2] However, MSFC–HDBK–505 also stipulates conditions where a less conservative safety factor of 1.4 and less conservative knockdown factors are appropriate if they have been verified by testing.[2] SRB document 90PLN–0064 provides requirements for qualification testing the strut retainer assembly.[3]

2. BACKGROUND

The restraint cable assembly is a steel cable with two terminal wire-rope clevis ends, pins, and cotter pins. The clevis ends and pins are picked from standard military specification hardware to interface with the external tank attachment ring and the diagonal strut assembly (figs. 1 and 2). The terminal wire-rope clevis ends are swaged onto the steel cable in accordance with MIL–T–6117.[4]

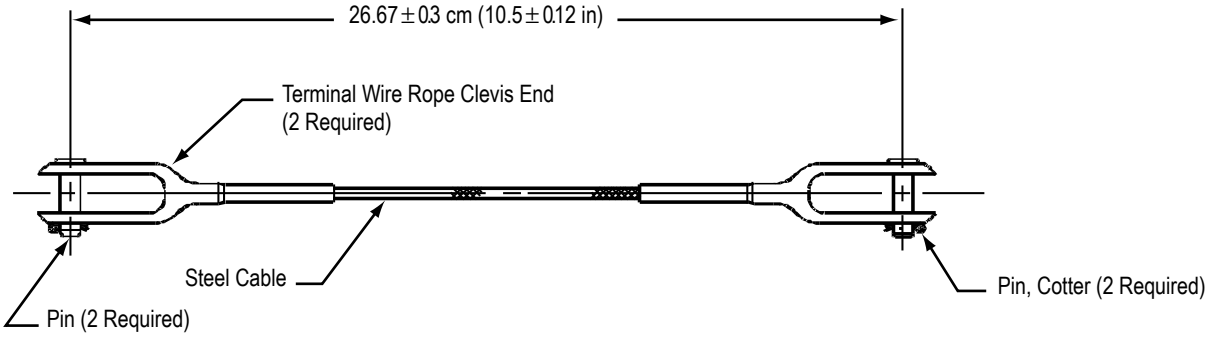

Figure 1. Strut retainer assembly.

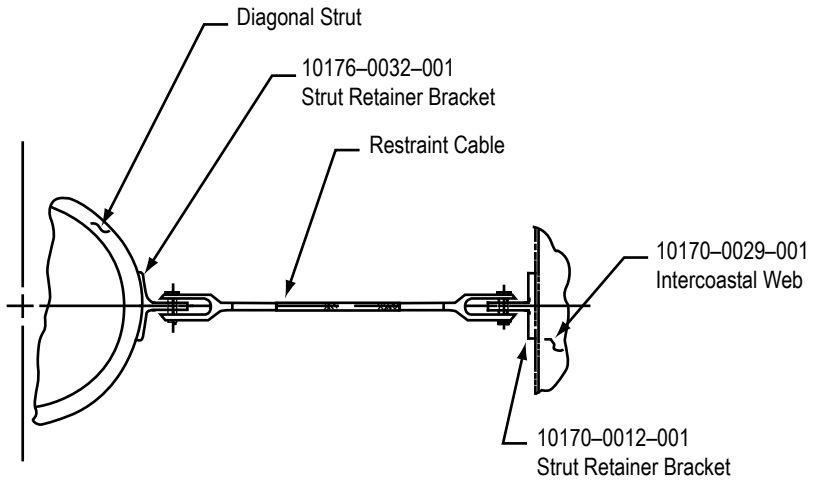

Figure 2. Strut retainer assembly installation.

This TM presents test results for three lots of MIL–W–83420, 0.317-cm (0.125- or 1/8-in) diameter, type 1 (nonjacketed) cable to loads required to restrain the diagonal strut during the first 2 min of flight and, ultimately, to failure.[1] The first lot consisted of available flight cable assemblies that existed in United Space Alliance (USA) stock. The other two lots were obtained from new procurements, with

documentation that the wire ropes are from two different wire lots or spools. Test results qualified the available restraint cable assemblies and all future buys of restraint cables manufactured under the same procurement specifications for flight.

3. TESTING AND EVALUATION

3.1 Testing

Mechanical testing was completed June 6, 2004 and was performed in accordance with ASTM–E–8 and test procedure SRB–QUAL–04–0064 for the first lot of cables.[5,6] Five restraint cables were each pulled to failure at room temperature and at 671 ± 5 °C (1,240 ± 10 °F) in accordance with the referenced procedure, 90PLN–0064, and memorandum MP41 (04–063).[3,7] Testing was completed for the other two lots on August 6, 2004. Ten additional restraint cables were each pulled to failure at room temperature and at 677 °C (1,250 °F) in accordance with the referenced procedure and plan.[3]

Table 1 shows analysis of the test results, including the calculation of a knockdown factor using methods described in chapter 9 of MIL–HDBK–5.[8]

Each cable was photographed before and after testing. All tests at room temperature were videotaped, and appendix A shows still images taken from the videos.

Procedure checklists were used for each test, in accordance with SRB–QUAL–04–0064, and they are shown in appendix B of this TM.[6]

3.2 Evaluation

A value, *R*, was calculated for each pair of room temperature and elevated temperature tests. This value is the reduced ratio for the peak load tests at the elevated temperature, 677 °C (1,250 °F), and room temperature. Mean and standard deviations were then calculated for the *R* value.

Table 1. Mechanical test results.

ID	Test Temperature (°F)	Peak Load (lb)	Ratio, r
5369RT–1 (408899)	73	1776.7	–
5369RT–2 (408899)	72	1781.9	–
5369RT–3 (408899)	72	1797.7	–
5369RT–4 (408899)	72	1792.5	–
5369RT–5 (408899)	71	1779.8	–
104236RT–1	71	1900.3	–
104236RT–2	71	1863.3	–
104236RT–3	71	1899.4	–
104236RT–4	71	2008.5	–
104236RT–5	71	1981.6	–
071081RT–1	70	1956.8	–
071081RT–2	70	1954.4	–
071081RT–3	71	1891.5	–
071081RT–4	70	1925.6	–
071081RT–5	71	1939.8	–
Average	–	1883.32	–
5369ELV–6 (408899)	1,250	322.2	0.1813
5369ELV–7 (408899)	1,259	342.1	0.192
5369ELV–8 (408899)	1,258	323	0.1797
5369ELV–9 (408899)	1,254	330.3	0.1843
5369ELV–10 (408899)	1,254	337.8	0.1898
104236ELV–6	1,253	387.8	0.2041
104236ELV–7	1,259	370.6	0.1989
104236ELV–8	1,251	399.8	0.2105
104236ELV–9	1,250	392.7	0.1955
104236ELV–10	1,251	402.4	0.2031
071081ELV–6	1,251	374.7	0.1915
071081ELV–7	1,254	383.2	0.1961
071081ELV–8	1,252	388.8	0.2056
071081ELV–9	1,258	358	0.1859
071081ELV–10	1,240	361.3	0.1863
		sum =	2.9
		r-bar =	0.1936
		s =	0.0094
		At 677 °C (1,250 °F), knockdown factor *R* =	0.1892

At the working temperature of 677 °C (1,250 °F), the lower 95-percent confidence interval estimate, or reduced ratio, of the mean percentage was determined from percentage values for each lot at that temperature. If *r* equals percentage values, *r*-bar equals the average of these values, and *n* equals the number of such percentages, estimated standard deviation, *s*, and reduced ratio, *R*, can be determined using the equation:

$$S^2 = \text{sum}\left(r - r\text{-bar}\right)^2 \Big/ \left(n-1\right) \ , \tag{1}$$

or

$$S^2 = \left[\text{sum}\left(r^2\right) - \left(\text{sum}\ r\right)^2 \Big/ n\right] \Big/ \left(n-1\right) \ , \tag{2}$$

and

$$R = r\text{-bar} - ts\Big/n^{1/2} \quad , \tag{3}$$

where t is a 0.95 fractal of the t distribution corresponding to n–1 degrees of freedom. In this case, the t used was $t = 1.753$ for alpha = 0.95 and $n = 30$.

4. CONCLUSIONS

A calculated knockdown factor of 0.1892 was determined for the restraint cables. That value will be used during structural analysis of the restraint cables in the elevated temperature condition. When combined with the minimum breaking strength of 0.317-cm (0.125- or 1/8-in) diameter, type 1 composition rope according to table 1A of MIL–W–83420, this knockdown factor provides a minimum breaking strength of 151 kg (333 lb) at 677 °C (1,250 °F).[1]

APPENDIX A—PHOTOGRAPHS BEFORE AND AFTER TESTING

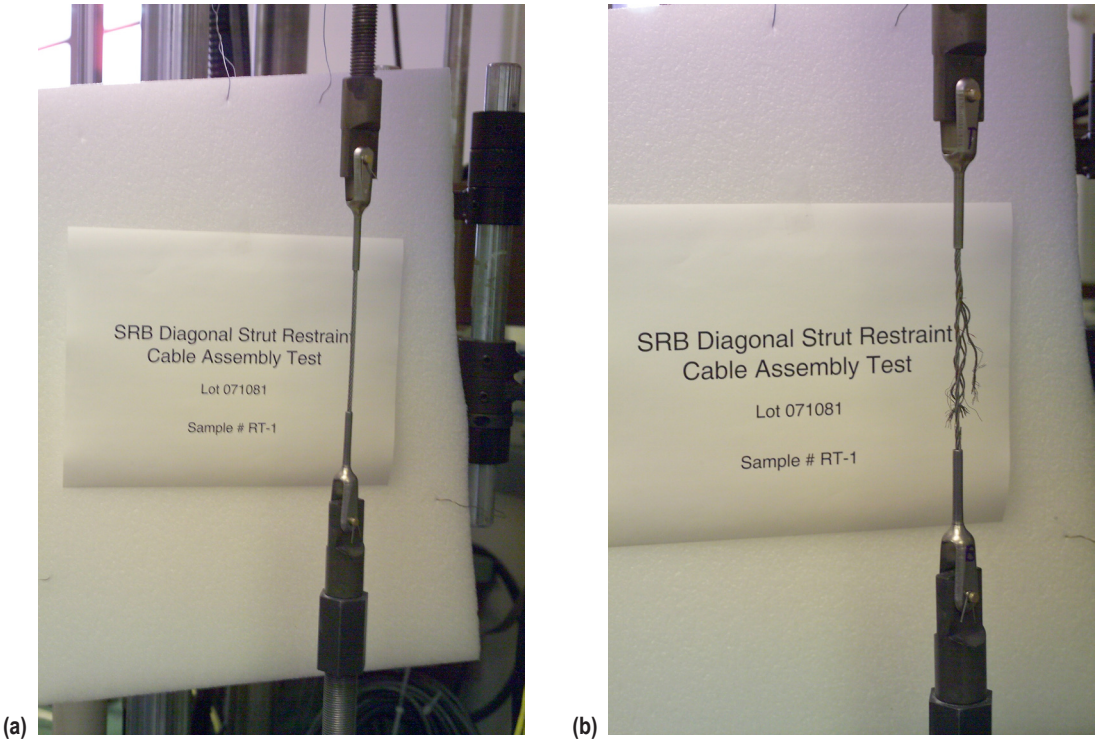

Figure 3. 071081–RT–1 (a) before testing and (b) after testing.

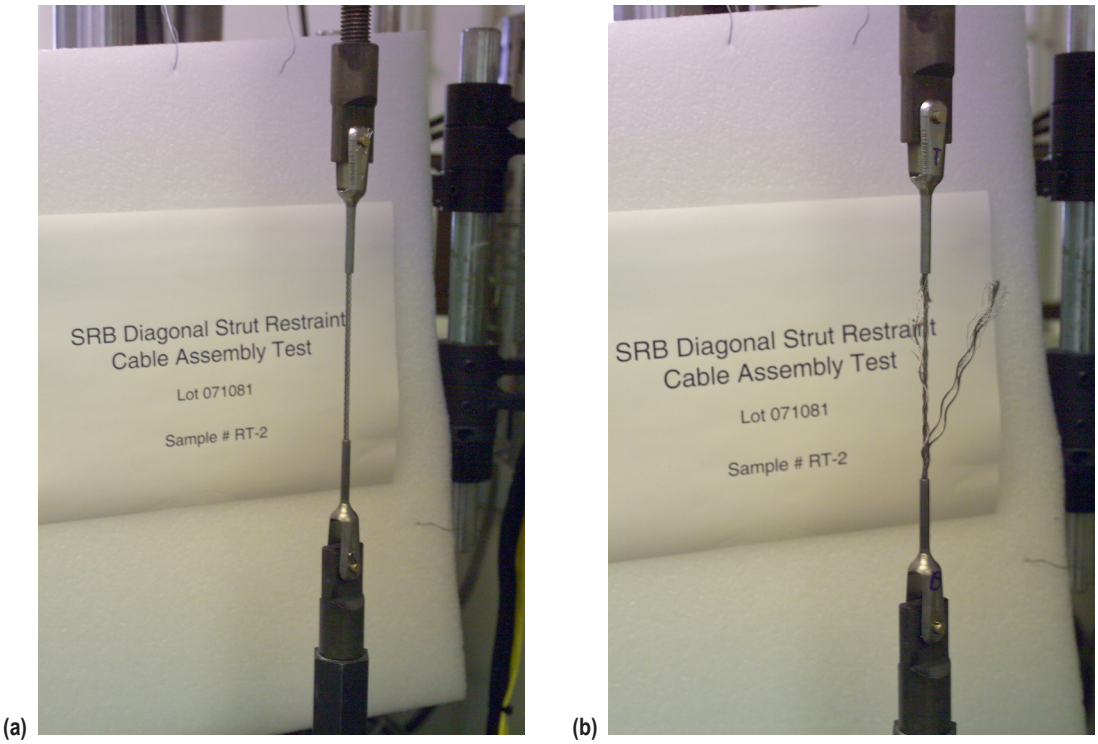

Figure 4. 071081–RT–2 (a) before testing and (b) after testing.

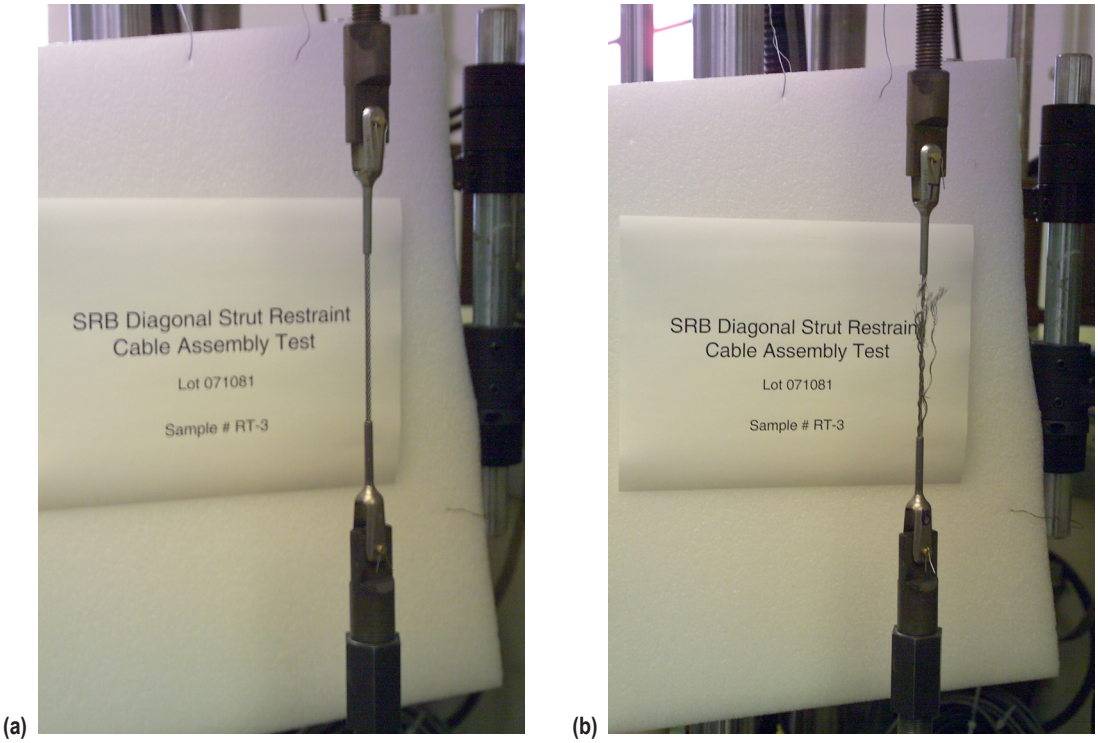

Figure 5. 071081–RT–3 (a) before testing and (b) after testing.

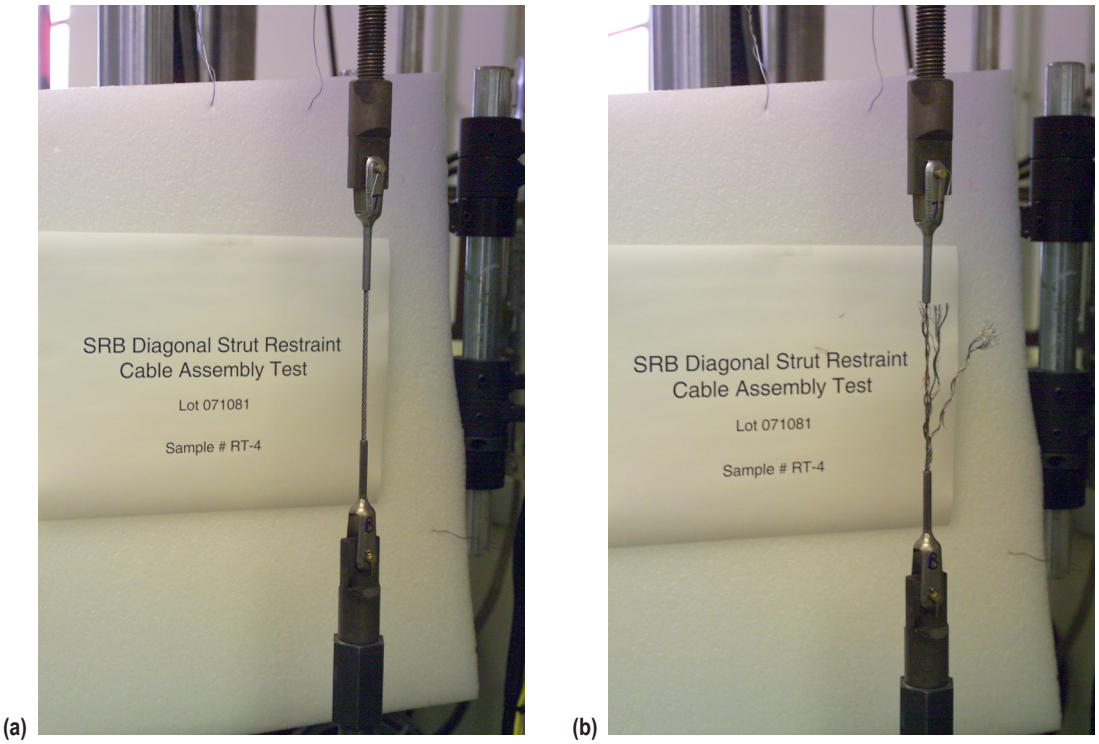

Figure 6. 071081–RT–4 (a) before testing and (b) after testing.

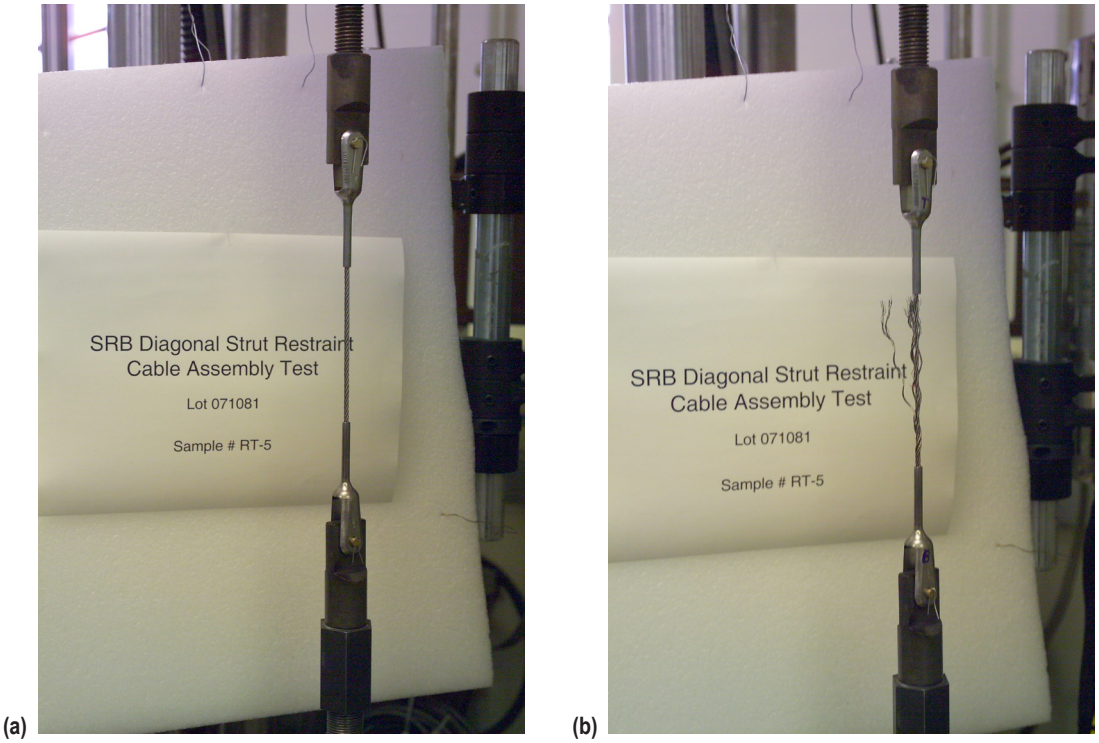

Figure 7. 071081–RT–5 (a) before testing and (b) after testing.

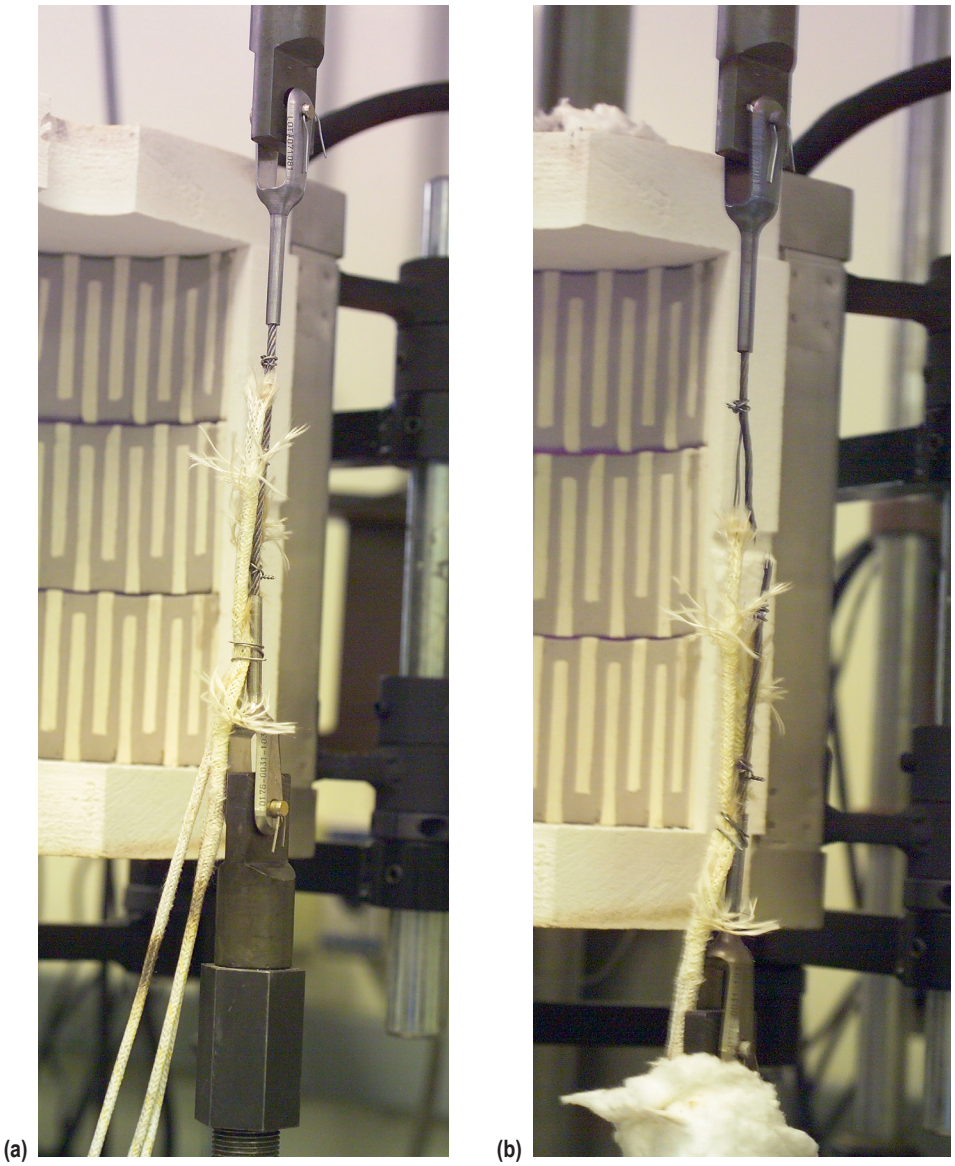

Figure 8. 071081–ELV–6 (a) before testing and (b) after testing.

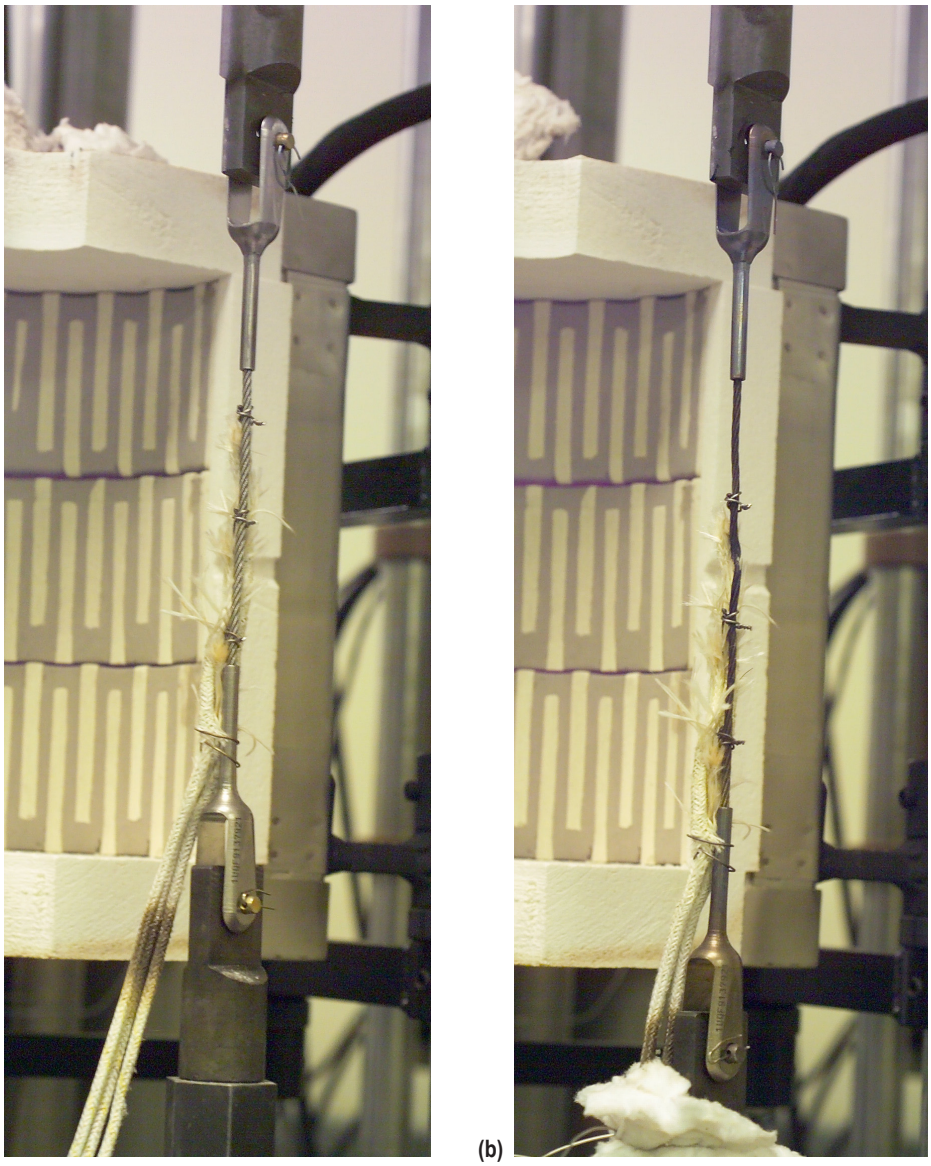

Figure 9. 071081–ELV–7 (a) before testing and (b) after testing.

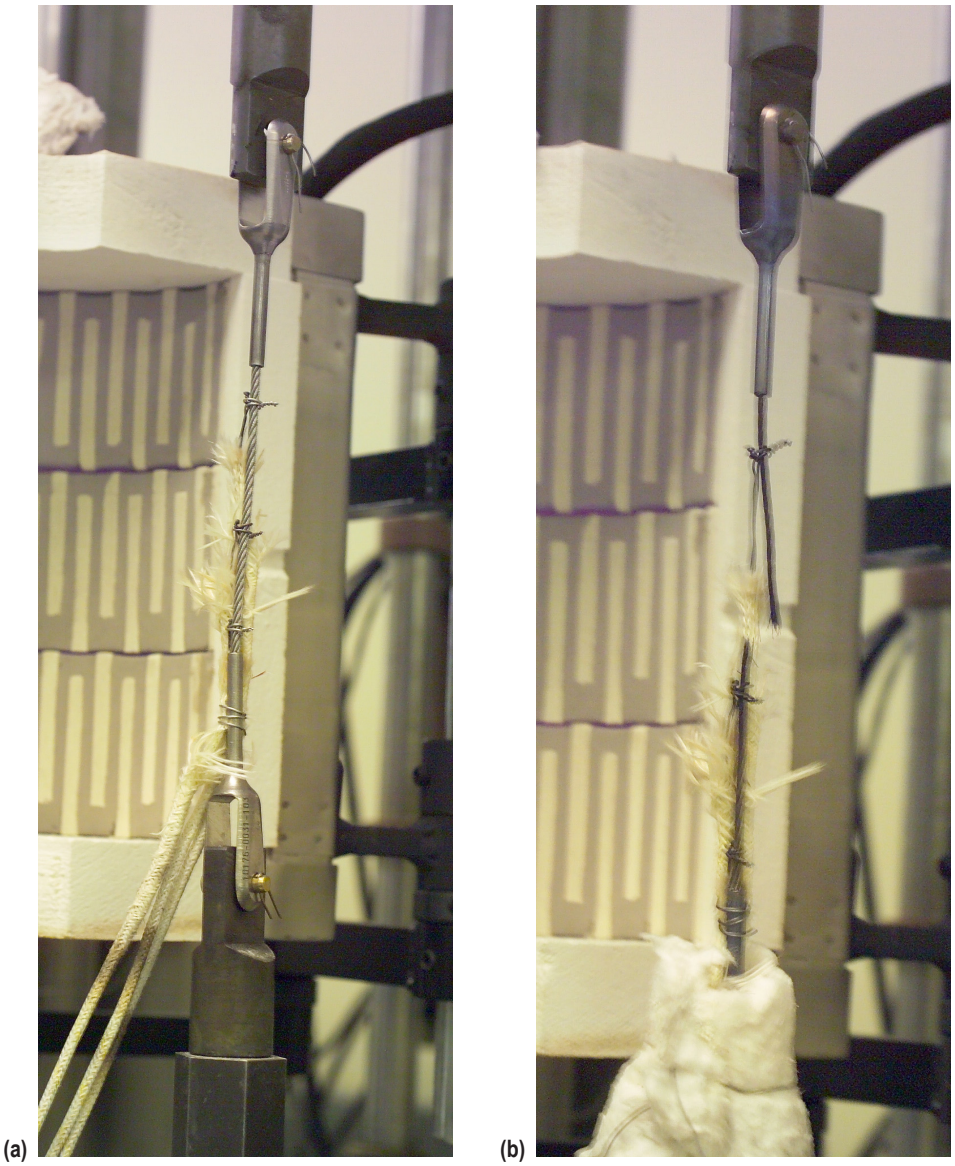

Figure 10. 071081–ELV–8 (a) before testing and (b) after testing.

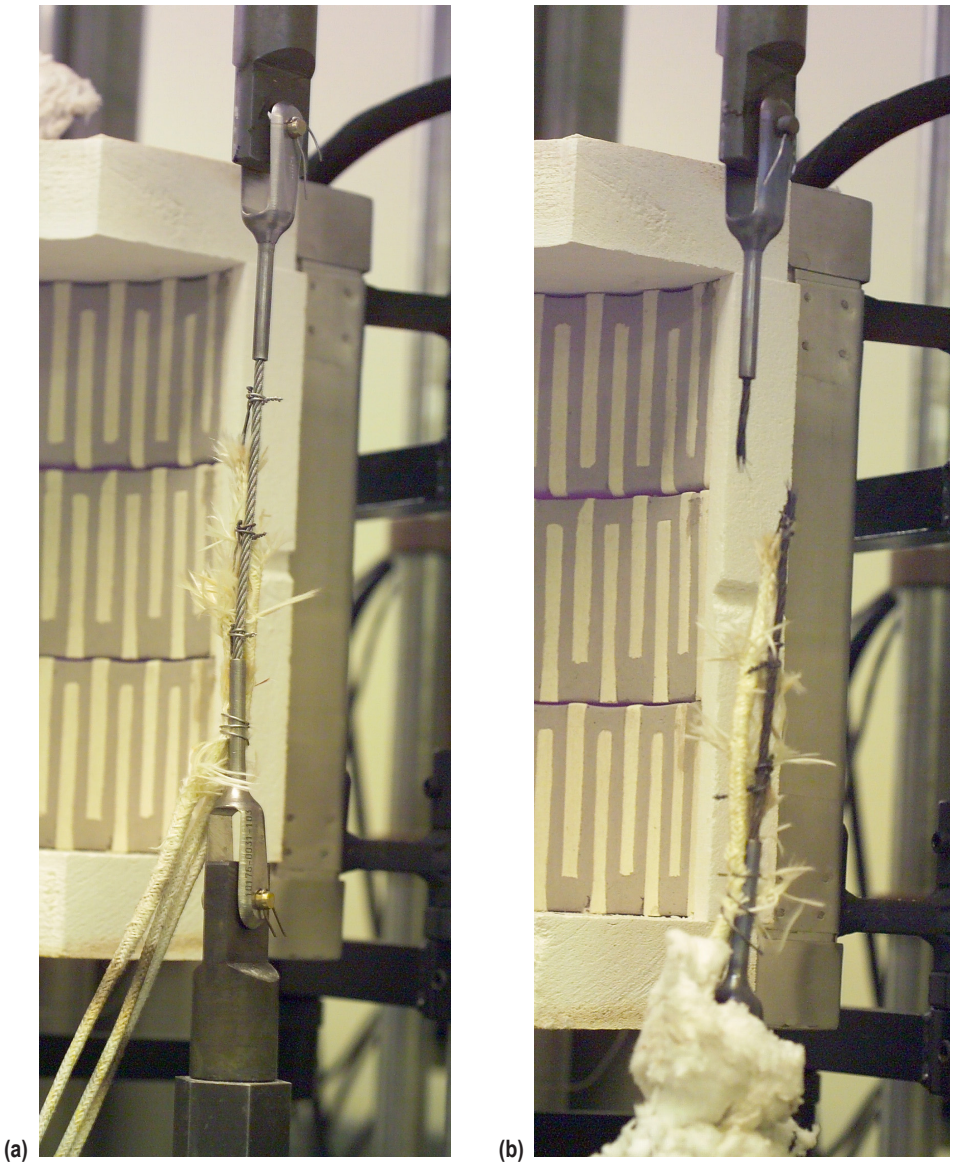

Figure 11. 071081–ELV–9 (a) before testing and (b) after testing.

Figure 12. 071081–ELV–10 (a) before testing and (b) after testing.

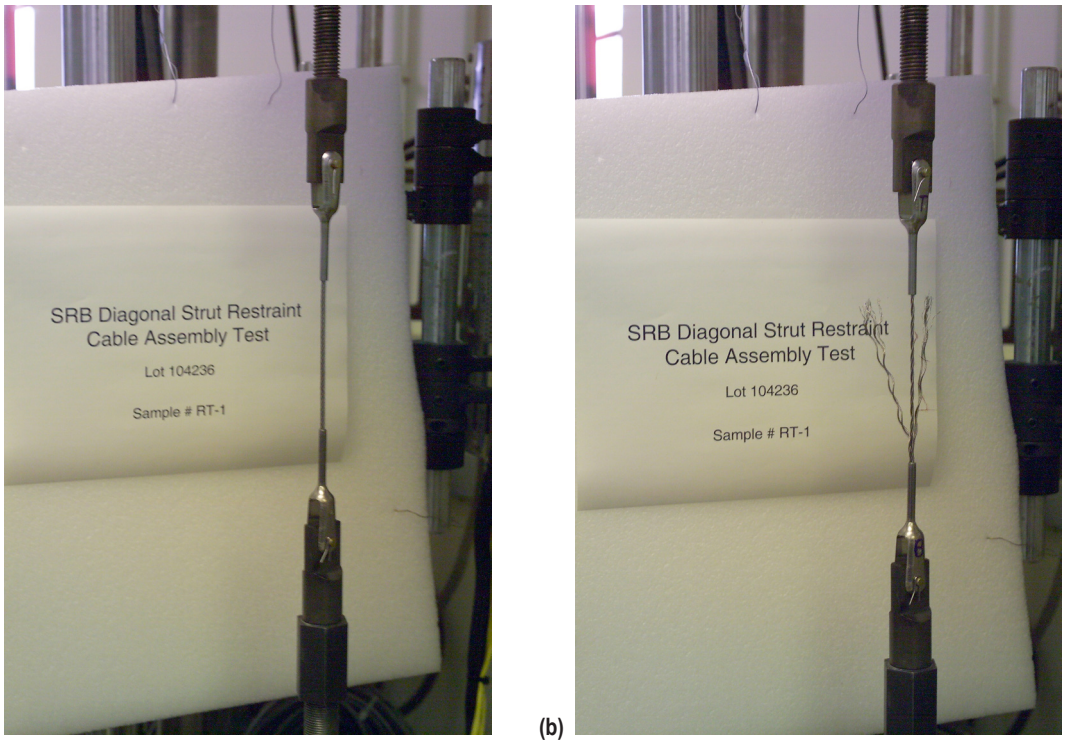

Figure 13. 104236–RT–1 (a) before testing and (b) after testing.

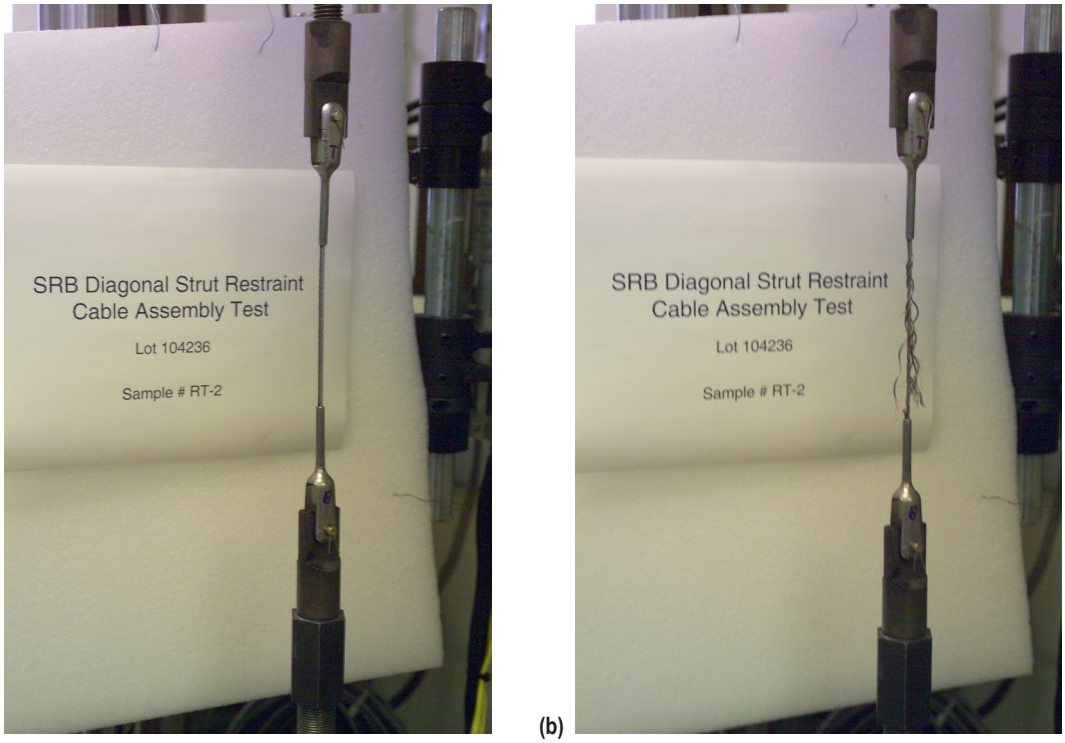

Figure 14. 104236–RT–2 (a) before testing and (b) after testing.

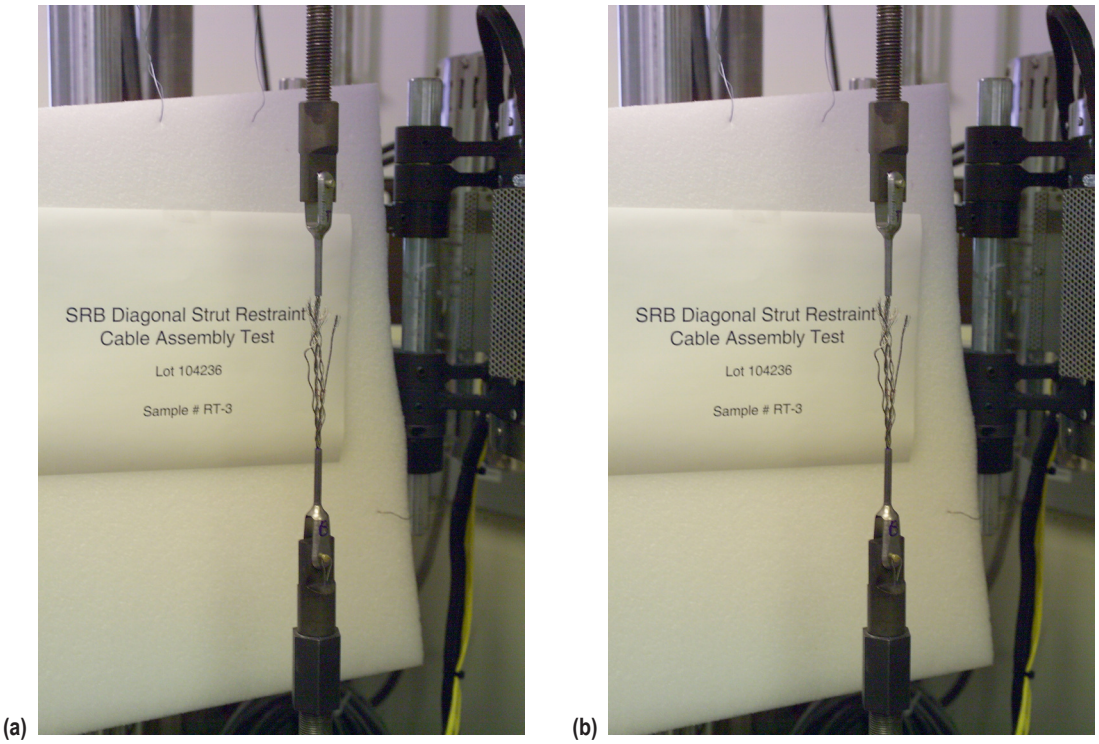

Figure 15. 104236–RT–3 (a) before testing and (b) after testing.

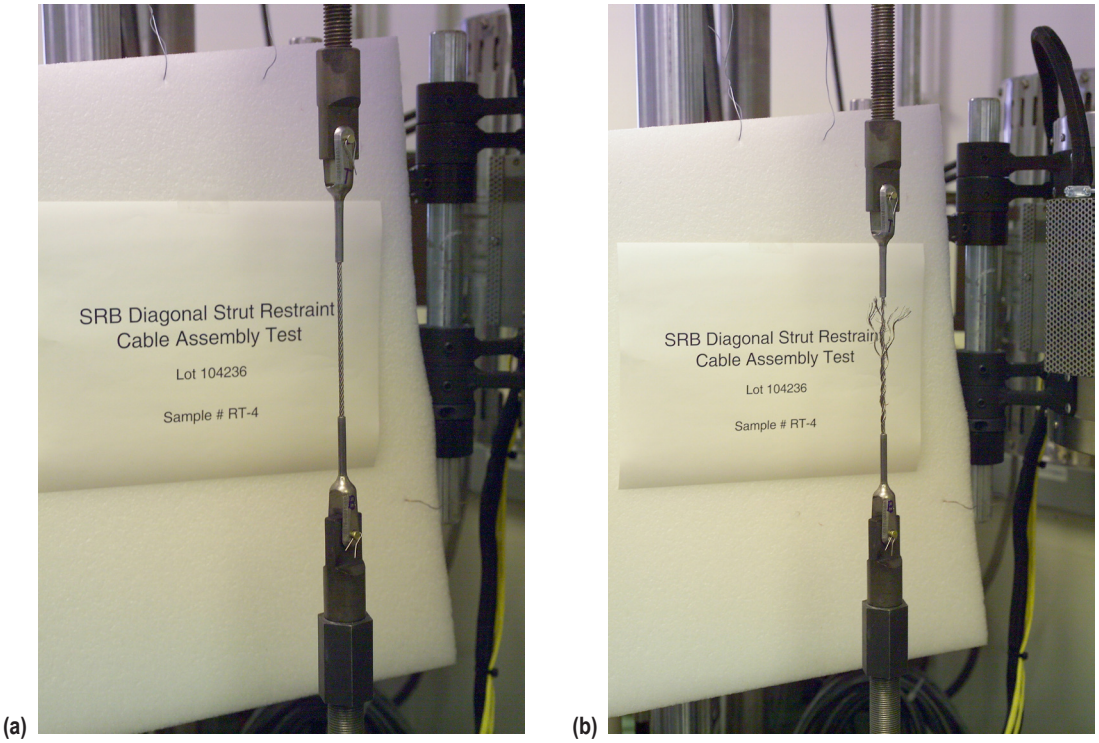

Figure 16. 104236–RT–4 (a) before testing and (b) after testing.

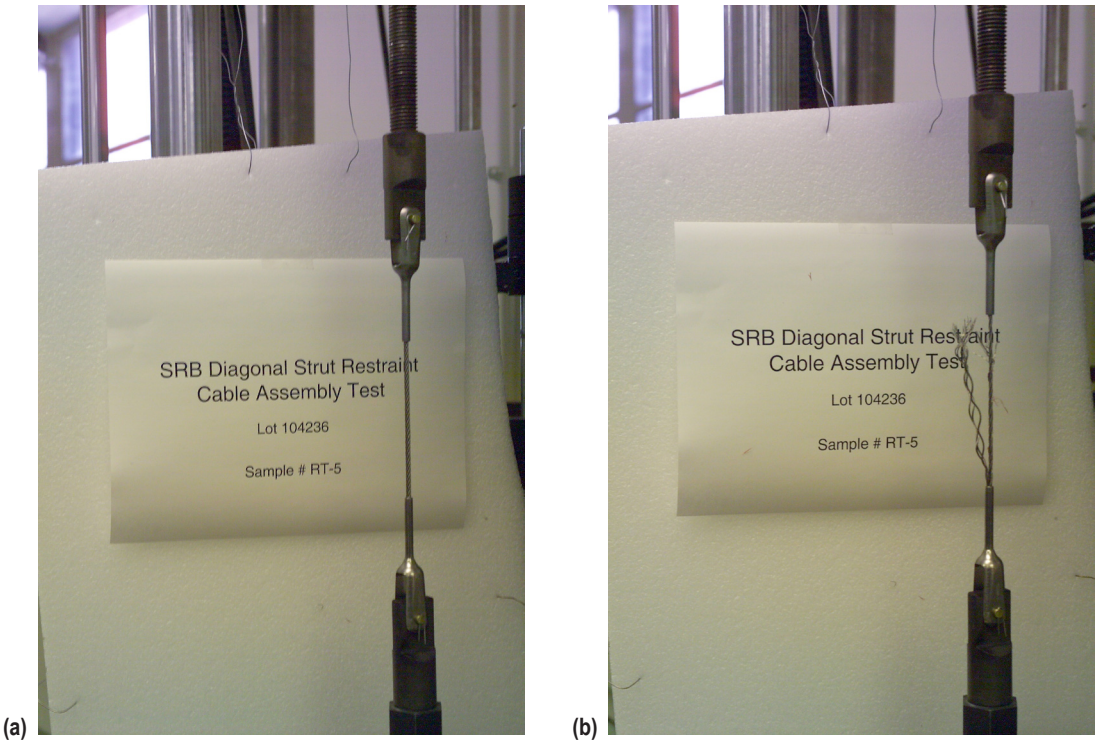

Figure 17. 104236–RT–5 (a) before testing and (b) after testing.

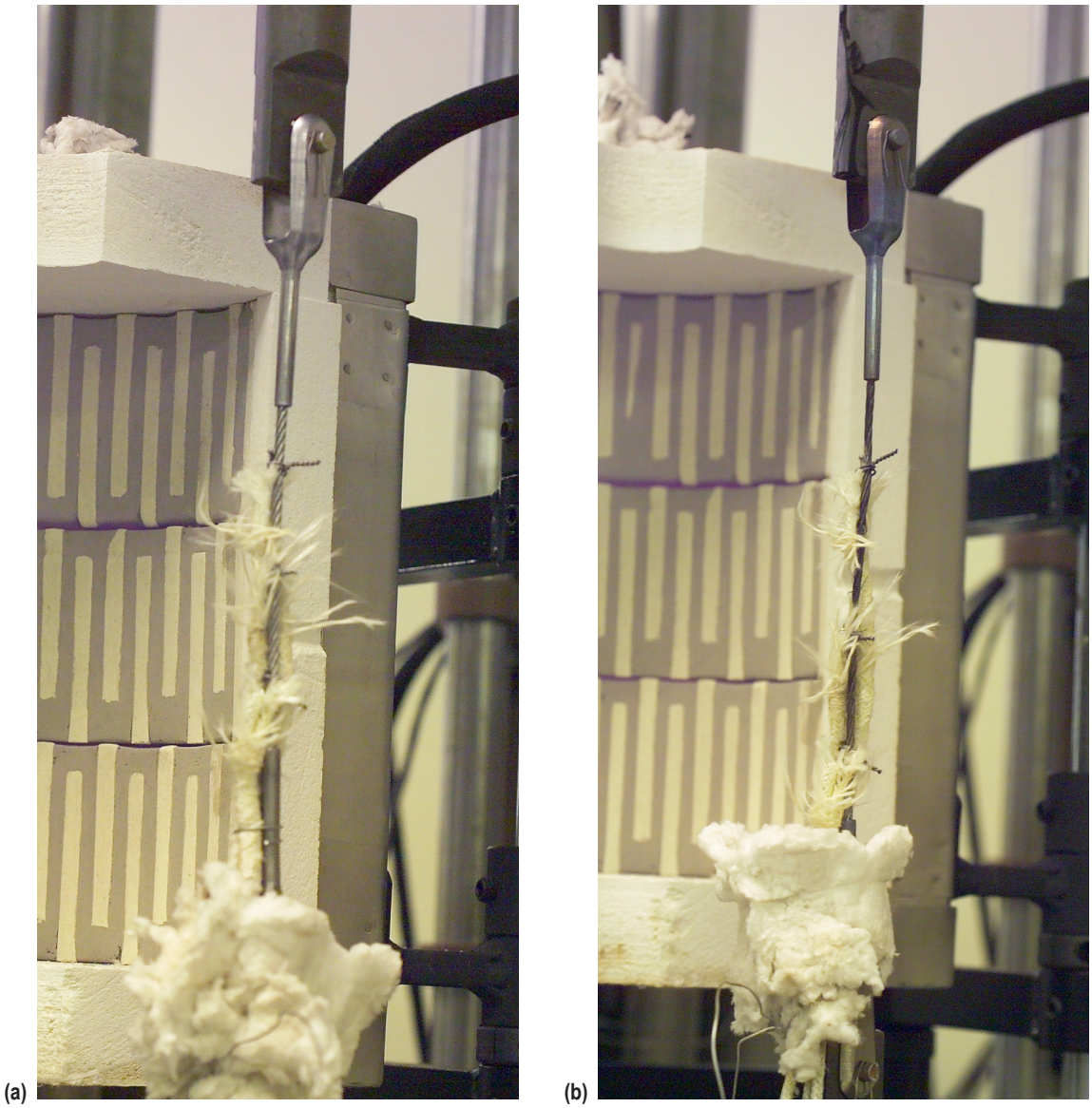

Figure 18. 104236–ELV–6 (a) before testing and (b) after testing.

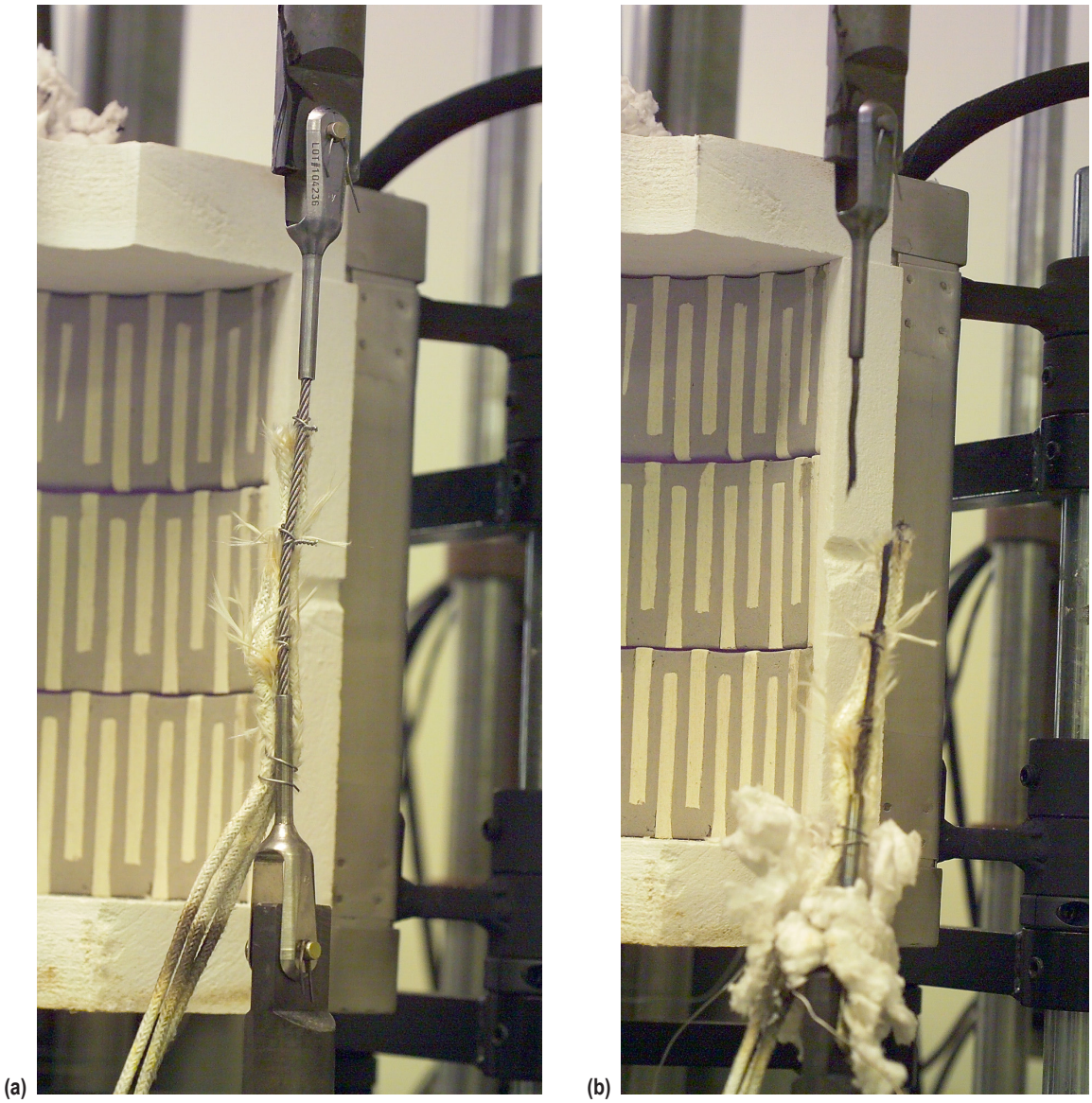

Figure 19. 104236–ELV–7 (a) before testing and (b) after testing.

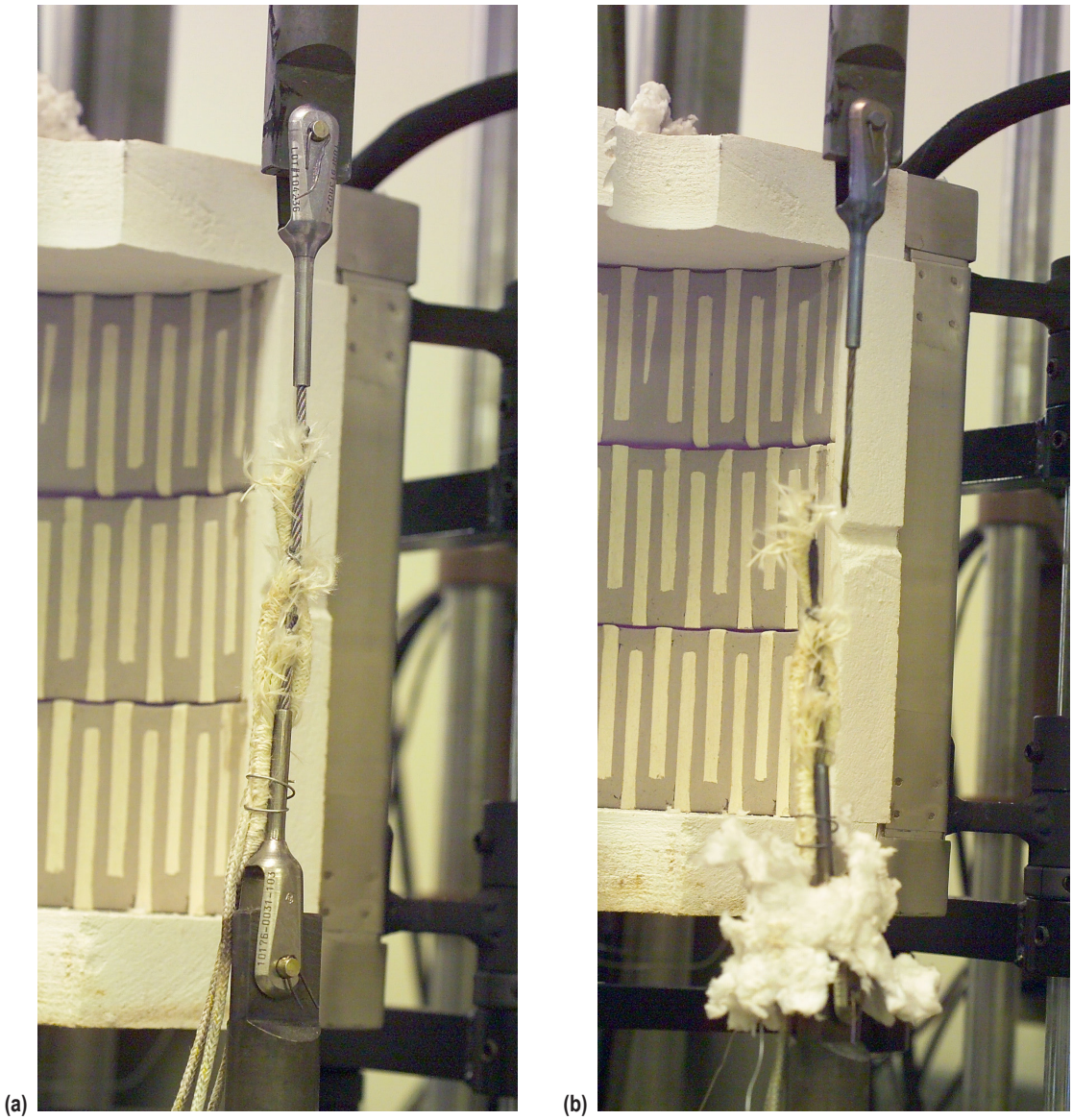

Figure 20. 104236–ELV–8 (a) before testing and (b) after testing.

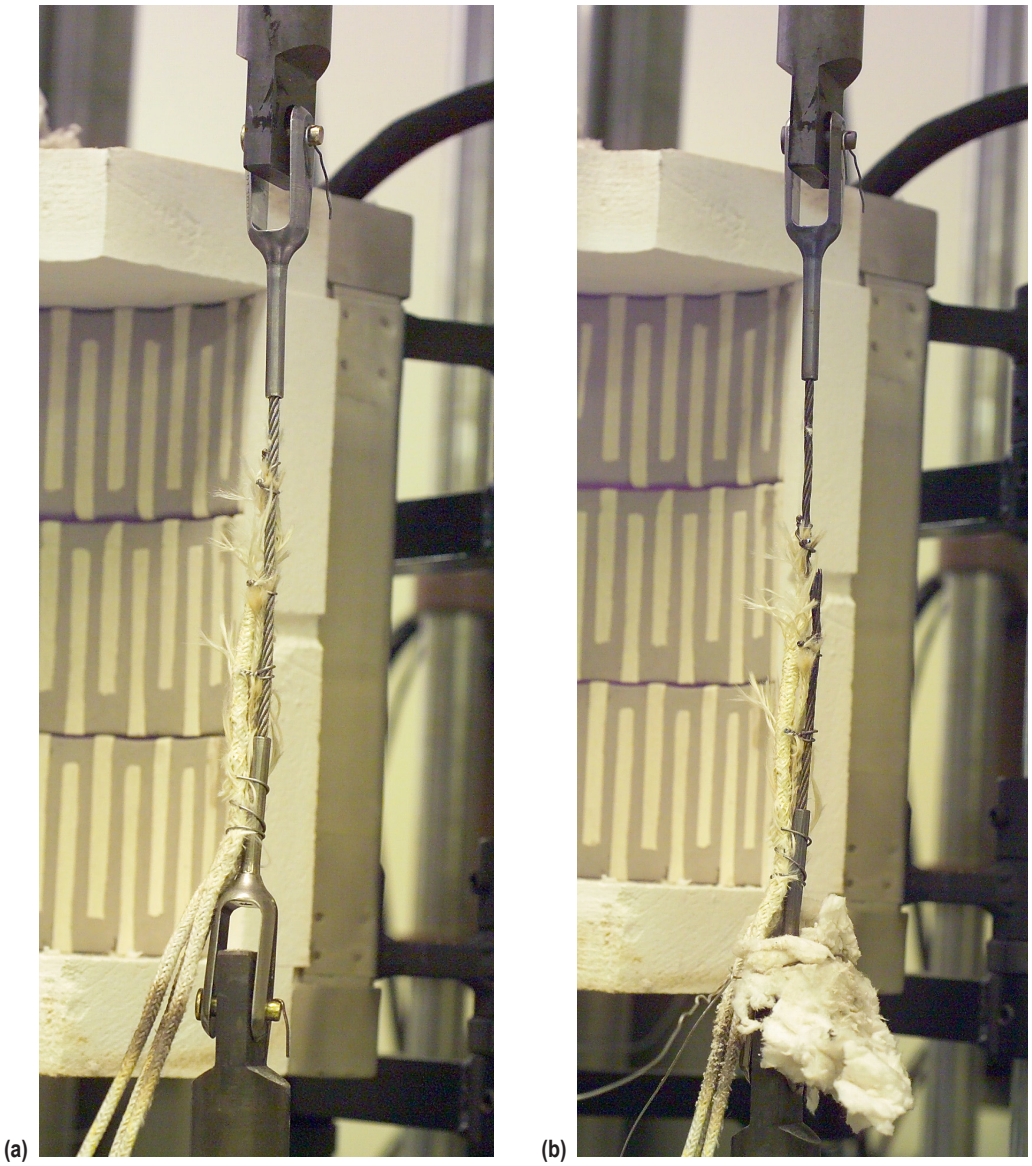

Figure 21. 104236–ELV–9 (a) before testing and (b) after testing.

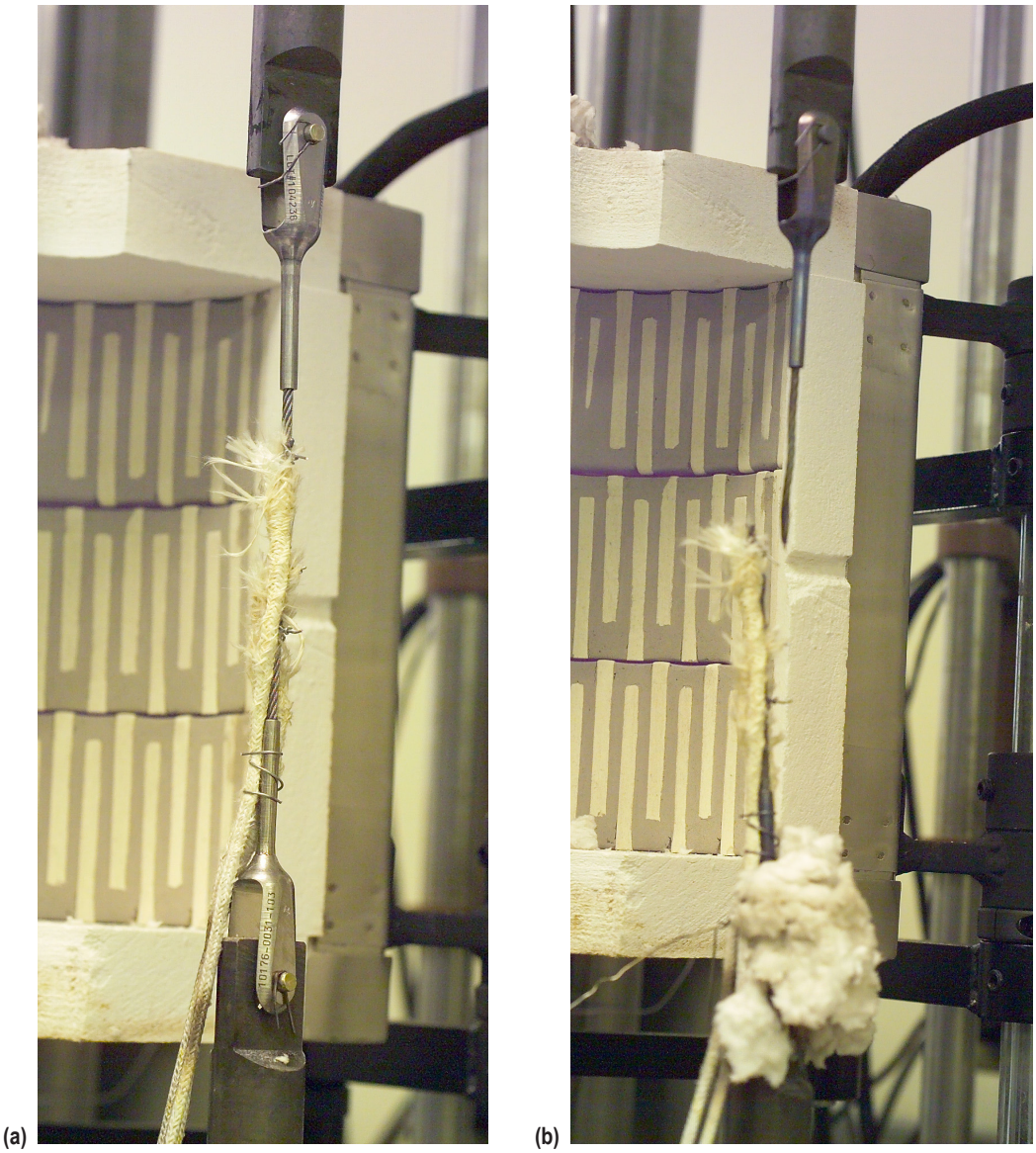

Figure 22. 104236–ELV–10 (a) before testing and (b) after testing.

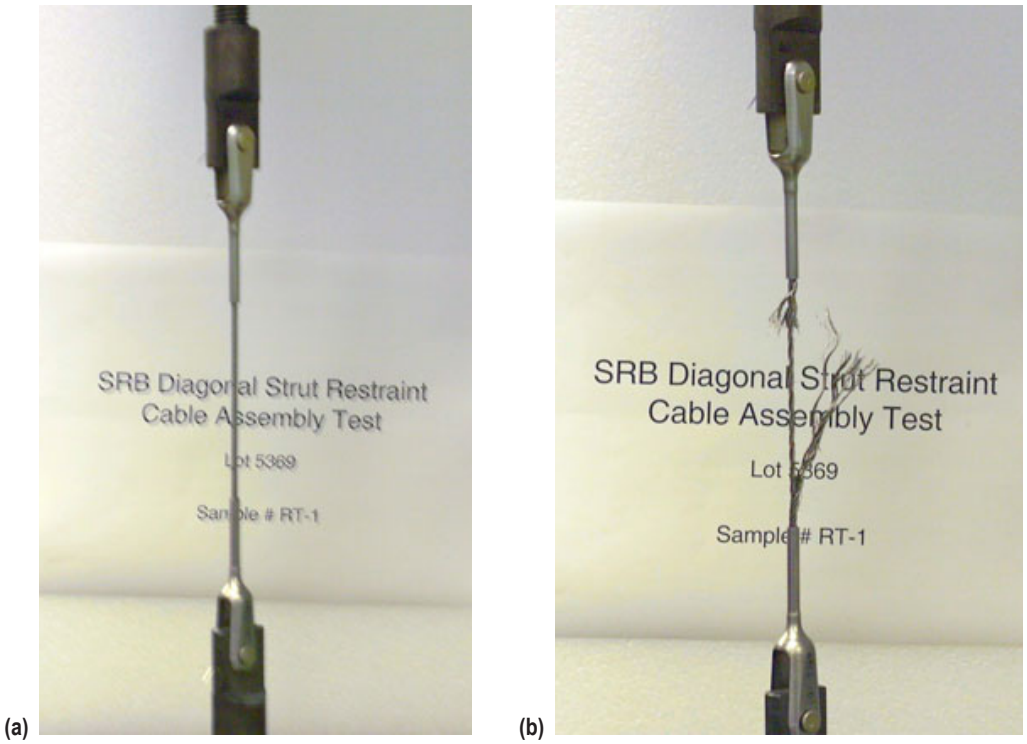

Figure 23. 5369–RT–1 (a) before testing and (b) after testing.

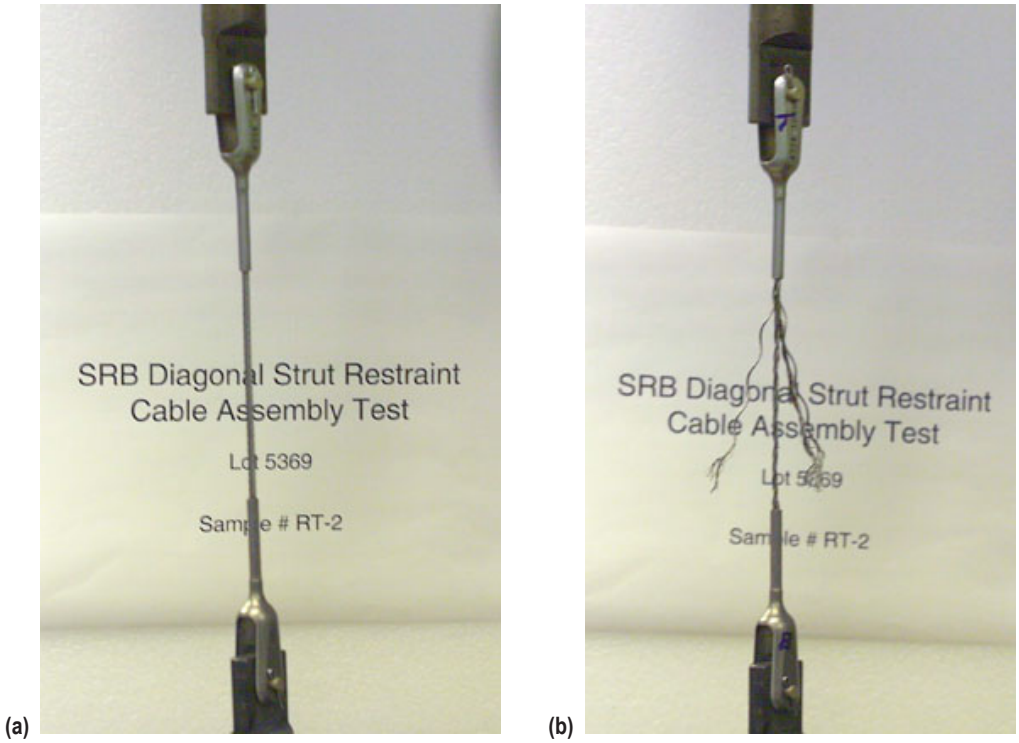

Figure 24. 5369–RT–2 (a) before testing and (b) after testing.

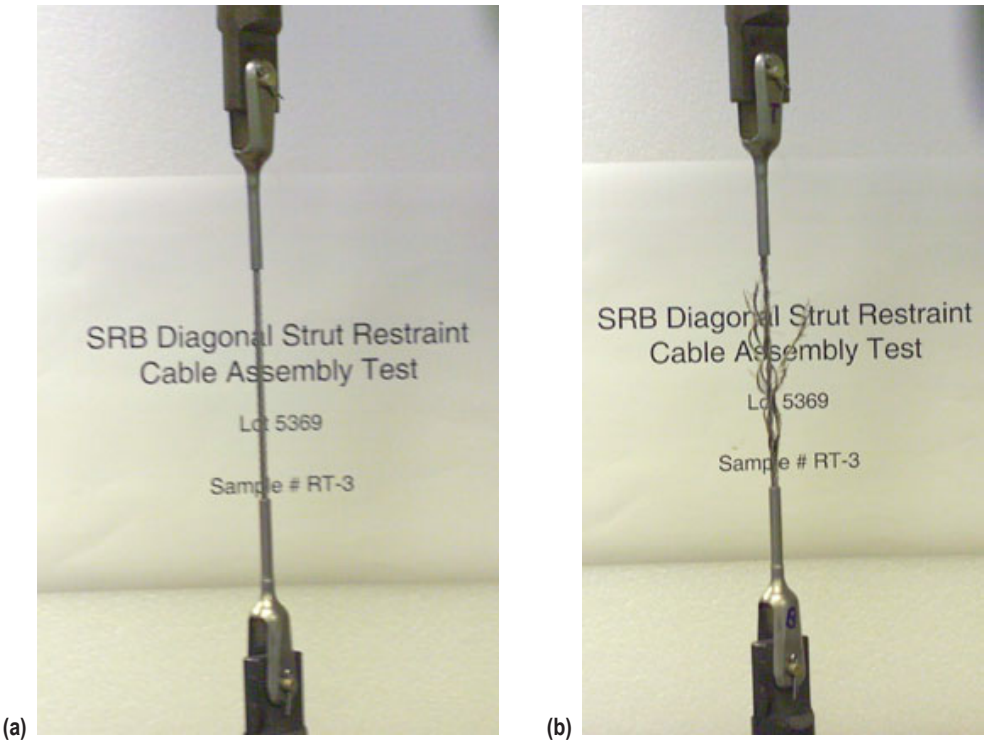

Figure 25. 5369–RT–3 (a) before testing and (b) after testing.

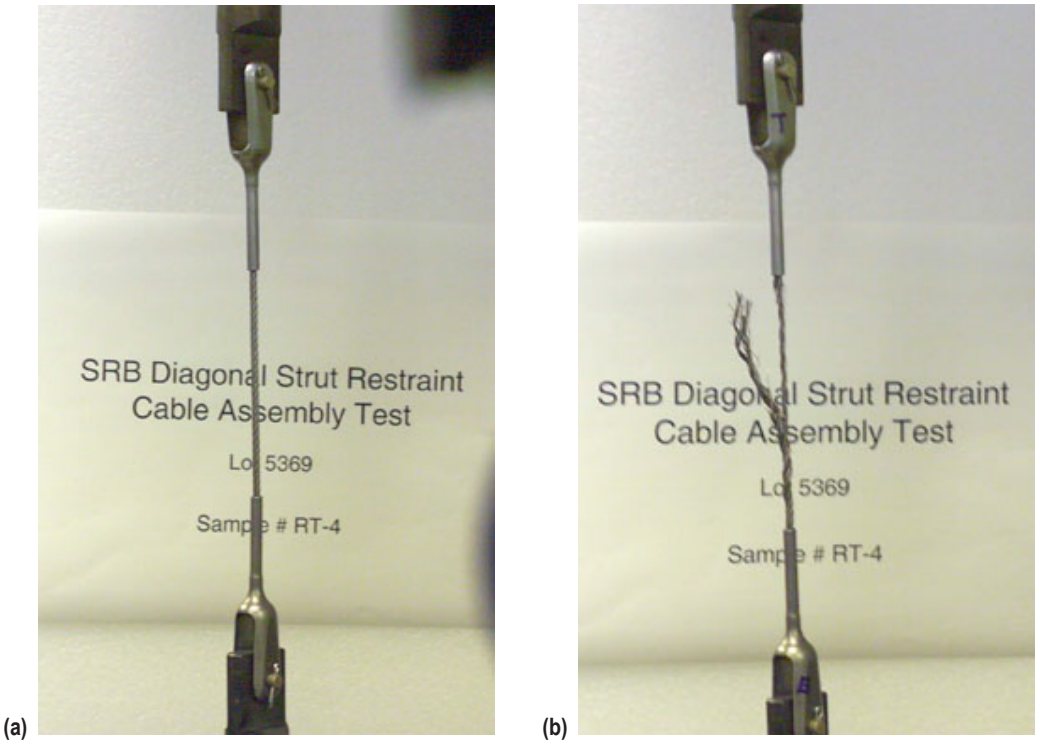

Figure 26. 5369–RT–4 (a) before testing and (b) after testing.

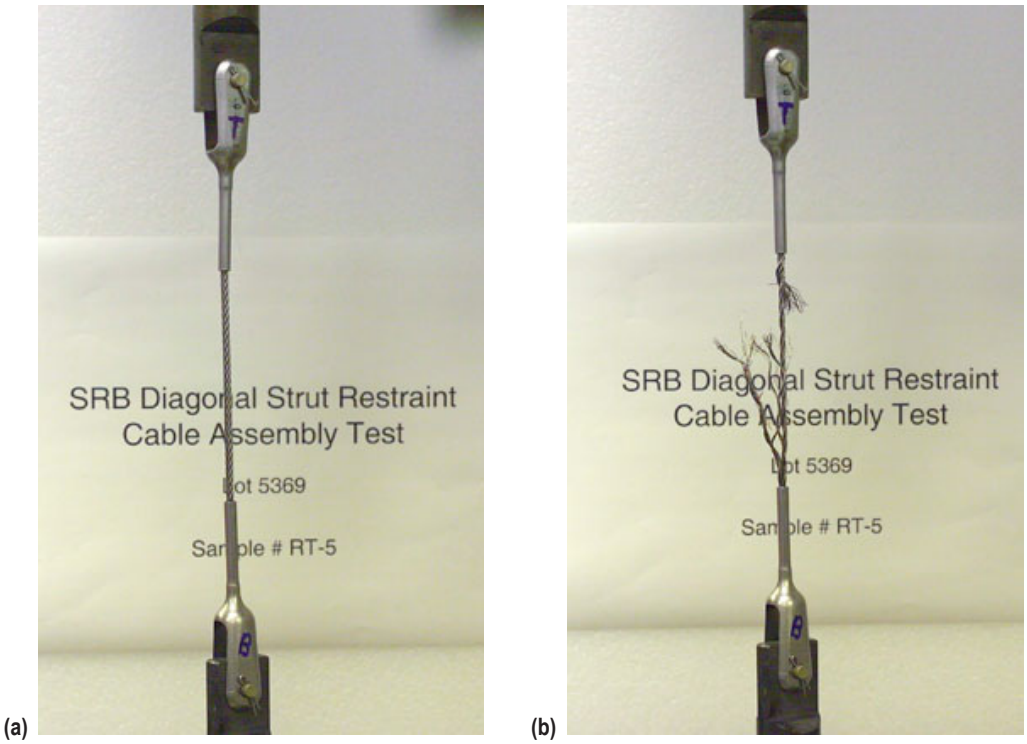

Figure 27. 5369–RT–5 (a) before testing and (b) after testing.

Figure 28. 5369–ELV–6 (a) before testing and (b) after testing.

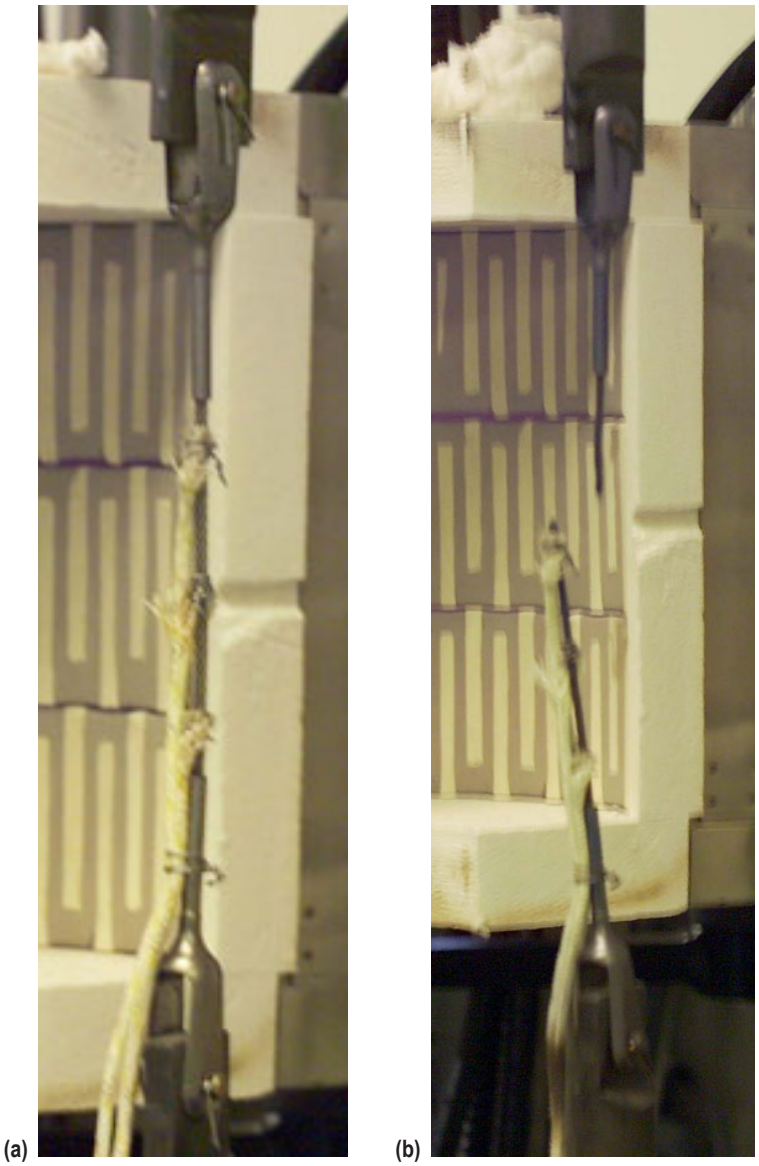

Figure 29. 5369–ELV–7 (a) before testing and (b) after testing.

Figure 30. 5369–ELV–8 (a) before testing and (b) after testing.

Figure 31. 5369–ELV–9 (a) before testing and (b) after testing.

Figure 32. 5369–ELV–10 (a) before testing and (b) after testing.

APPENDIX B—PROCEDURE CHECKLISTS

Attachment 1

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
	Date: 7/26/04	Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 340 7-28-04

Verify PQAR POAR USA 4

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 RT-1

M NASA 340 7-28-04 ✓

Verify PQAR POAR USA 4

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 340 7-28-04 ✓

Verify PQAR POAR USA 4

X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

N/A M NASA 340 7-28-04

Verify PQAR N/A POAR USA 4

6.0.5 Photograph set-up.

✓

X 6.0.6 Install furnace and heat to 1250F (HT tests only).

N/A M NASA 340 7-28-04

Verify PQAR N/A POAR USA 4

6.0.7 Begin video.

✓

X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

N/A M NASA 340 7-28-04

Verify PQAR N/A

6.0.9 Document temperature of test article. 73° F

Witness PQAR POAR USA 4 ✓

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 42.4 lbs

M NASA 340 7-28-04 ✓

Witness PQAR POAR USA 4

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

M NASA 340 7-28-04 ✓

Verify PQAR POAR USA 4

6.0.12 Continue increase load until failure occurs.:

Witness PQAR POAR USA 4 ✓

POAR USA 4 M NASA 340

6.0.13 Verify load and instrumentation.

Verify PQAR M NASA 340 7-28-04 ✓ PQAR USA 4

6.0.14 Stop video. M NASA 340 7-28-04 ✓ PQAR USA 4

6.0.15 Document load and location of failure:
Failure load 1776.7
Failure location:
N/A swage
4" - Top inches from cable end Center Line Top Pin
N/A other

Verify PQAR PQAR USA 4 M NASA 340 7-28-04 ✓

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. M NASA 340 7-28-04 ✓ PQAR USA 4

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

PQAR USA 4 M NASA 340 7-28-04

Attachment #2

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 84Q 7-28-04

Verify PQAR POAR USA 4 ✓

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 RT-2

M NASA 84Q 7-28-04

Verify PQAR POAR USA 4 ✓

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 84Q 7-28-04 ✓

Verify PQAR POAR USA 4

X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

M NASA 84Q 7-28-04 N/A

Verify PQAR N/A

6.0.5 Photograph set-up.

M NASA 84Q 7-28-04 ✓

X 6.0.6 Install furnace and heat to 1250F (HT tests only).

M NASA 84Q 7-28-04 N/A

Verify PQAR N/A

6.0.7 Begin video.

M NASA 84Q 7-28-04 ✓

X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

M NASA 84Q 7-28-04 N/A

Verify PQAR N/A

6.0.9 Document temperature of test article. 72° F

Witness PQAR POAR USA 4 ✓

~~6.0.10~~ ~~Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.~~ 41.1

M NASA 84Q 7-28-04

Witness PQAR POAR USA 4 ✓

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

M NASA 84Q 7-28-04 ✓

Verify PQAR POAR USA 4

6.0.12 Continue increase load until failure occurs.:

Witness PQAR POAR USA 4

POAR USA 4 M NASA 84Q

6.0.13 Verify load and instrumentation. 7-28-04

Verify PQAR

6.0.14 Stop video. 7-28-04

6.0.15 Document load and location of failure:
Failure load 1781.9
Failure location:
N/A swage
7 3/4 - T inches from cable end
N/A other 7-28-04

Verify PQAR

6.0.16 Photograph set-up. 7-28-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 7-28-04

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

7-28-04

Attachment #3

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 340 7-28-04

Verify PQAR POAR USA 4 ✓

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 RT-3

M NASA 340 7-28-04

Verify PQAR POAR USA 4 ✓

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 340 7-28-04

Verify PQAR POAR USA 4

X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

N/A M NASA 340 7-28-04

Verify PQAR N/A POAR USA 4 ✓

6.0.5 Photograph set-up.

6.0.6 Install furnace and heat to 1250F (HT tests only).

N/A M NASA 340 7-28-04

Verify PQAR N/A POAR USA 4 ✓

6.0.7 Begin video.

X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

N/A M NASA 340 7-28-04

Verify PQAR N/A

6.0.9 Document temperature of test article. 72°F

M NASA 340 7-28-04

Witness PQAR POAR USA 4 ✓

~~6.0.10~~ ~~Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.~~ 41.1 lbs

M NASA 7-28-04 ✓

Witness PQAR POAR USA 4

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

M NASA 340 7-28-04 ✓

Verify PQAR POAR USA 4

6.0.12 Continue increase load until failure occurs.:

Witness PQAR POAR USA 4 ✓

POAR USA 4

M NASA 340

6.0.13 Verify load and instrumentation.

Verify PQAR 7-28-04

6.0.14 Stop video. 7-28-04

6.0.15 Document load and location of failure:
Failure load 1797.7
Failure location:
N/A swage
3½-T inches from cable end
N/A other

7-28-04

Verify PQAR

6.0.16 Photograph set-up. 7-28-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 7-28-04

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

7-28-04

Attachment 4

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 34Q 7-28-04 ✓

Verify PQAR PQAR USA 4

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 RT-4

M NASA 34Q 7-28-04

Verify PQAR PQAR USA 4 ✓

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 34Q 7-28-04 ✓

Verify PQAR PQAR USA 4

X 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

N/A M NASA 34Q 7-28-04

Verify PQAR N/A

6.0.5 Photograph set-up.

PQAR USA 4 ✓

X 6.0.6 Install furnace and heat to 1250F (HT tests only).

N/A M NASA 34Q 7-28-04

Verify PQAR N/A

6.0.7 Begin video.

PQAR USA 4 ✓

X 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

N/A M NASA 34Q 7-28-04

Verify PQAR N/A

6.0.9 Document temperature of test article. 72°F

Witness PQAR PQAR USA 4 ✓

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 44.2 lbs

M NASA 34Q 7-28-04 ✓

Witness PQAR PQAR USA 4

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

M NASA 34Q 7-28-04 ✓

Verify PQAR PQAR USA 4

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 ✓

M NASA 34Q

PQAR USA 4

7-28-04

6.0.13 Verify load and instrumentation. 7-28-04

Verify PQAR 7-28-04

6.0.14 Stop video.

6.0.15 Document load and location of failure:
Failure load 1792.5
Failure location:
N/A swage
3¾-T inches from cable end
N/A other

Verify PQAR 7-28-04

6.0.16 Photograph set-up. 7-28-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 7-28-04

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

7-28-04

Attachment #5

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 84Q 7-28-04 ✓

Verify PQAR POAR USA 4 ✓

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 RT-5

M NASA 84Q 7-28-04

Verify PQAR POAR USA 4 ✓

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 84Q 7-28-04 ✓

Verify PQAR POAR USA 4

✗ 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

N/A M NASA 84Q 7-28-04

Verify PQAR N/A

6.0.5 Photograph set-up.

M NASA 84Q 7-28-04 ✓

✗ 6.0.6 Install furnace and heat to 1250F (HT tests only).

N/A M NASA 84Q 7-28-04

Verify PQAR N/A

6.0.7 Begin video.

POAR USA 4 ✓

✗ 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

N/A M NASA 84Q 7-28-04

Verify PQAR N/A

6.0.9 Document temperature of test article. 71°F

POAR USA 4 ✓

Witness PQAR

~~6.0.10~~ ~~Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.~~ 41.5

M NASA 84Q 7-28-04 ✓

Witness PQAR POAR USA 4

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

M NASA 84Q 7-28-04 ✓

Verify PQAR POAR USA 4

6.0.12 Continue increase load until failure occurs.:

POAR USA 4

Witness PQAR ✓

POAR USA 4 M NASA 84Q

6.0.13 Verify load and instrumentation.

Verify PQAR 7-28-04

6.0.14 Stop video. 7-28-04

6.0.15 Document load and location of failure:
Failure load 1779.8
Failure location:
N/A swage
4¼-T inches from cable end
N/A other

Verify PQAR

6.0.16 Photograph set-up. 7-28-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 7-28-04

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

7-28-04

Attachment #6

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR ____ ____ ✓

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 Elv-6

Verify PQAR ____ ✓

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR ____ ____ ✓

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR ____ ✓ ____

6.0.5 Photograph set-up. ____ ✓

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR ____ ✓ ____

~~X~~6.0.7 Begin video. N/A M NASA S&Q 7-28-04

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR ____ ____

6.0.9 Document temperature of test article. 1258

Witness PQAR ____ ✓

~~6.0.10~~ Ramp load to approximately ~~45~~ pounds at a load rate not to exceed 5 inches per minute. 45.1 lbs

Witness PQAR ____ ✓ ____

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR ____ ✓ ____

6.0.12 Continue increase load until failure occurs.:

Witness PQAR ____ ✓

6.0.13 Verify load and instrumentation. * _____

Verify PQAR _____

6.0.14 Stop video. _____

6.0.15 Document load and location of failure: *

Failure load _____

Failure location: _____ swage

5 3/4 - T inches from cable end

_____ other

Verify PQAR _____

6.0.16 Photograph set-up. _____ ✓

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. _____ ✓

Verify PQAR _____

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

Changed Load Rate from 0.02 IN/min. to 0.2 IN/min.

198.8 lbs. max at 0.2 IN/min.

392.2 lbs. Impact Load to Breake Sample. Machine piston out of Range.

Attachment #7

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 7-28-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 Elv-7

Verify PQAR 7-28-0

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 7-28-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR 7-2804

6.0.5 Photograph set-up. 7-2804

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR 7-28-04

X 6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR 7-28-04

6.0.9 Document temperature of test article. 1259

Witness PQAR 7-2804

~~6.0.10~~ ~~Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.~~ 41.5 lbs 7-28-0

Witness PQAR

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR 7-28-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 4

6.0.13 Verify load and instrumentation.

Verify PQAR ✓ 7-28-04

X 6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 342.1
Failure location:
N/A swage
5"-T inches from cable end
N/A other

NOTE: LOAD RATE 0,8 IN/MIN PER TELECON

Verify PQAR 7-28-04

6.0.16 Photograph set-up. 7-28-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR ✓ 7-28-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

7-28-04

Attachment #8

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 7-28-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 Elv-8

Verify PQAR 7-28-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 7-28-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR 7-28-04

6.0.5 Photograph set-up. 7-28-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR 7-28-04

X 6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR 7-28-04

6.0.9 Document temperature of test article. 1258 °F

Witness PQAR 7-28-04

~~6.0.10~~ Ramp load to approximately ~~45~~ pounds at a load rate not to exceed 5 inches per minute. 43.165

Witness PQAR 7-28-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR 7-28-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 7-28-04

6.0.13 Verify load and instrumentation.

Verify PQAR 7-28-04

X 6.0.14 Stop video. N/A 7-28-04

6.0.15 Document load and location of failure:
Failure load 393.0
Failure location:
N/A swage
5 3/8-T inches from cable end
N/A other

Note: Load Rate 8.8 IN/MIN per Telecon

Verify PQAR 7-28-04

6.0.16 Photograph set-up. 7-28-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 7-28-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

7-28-04

Attachment 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR ✓ 7-28-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 Elv-9

Verify PQAR ✓ 7-28-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR ✓ 7-28-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR ✓ 7-28-04

6.0.5 Photograph set-up. ✓ 7-28-01

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR ✓ 7-28-01

X 6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR ✓ 7-28-01

6.0.9 Document temperature of test article. 1254°

Witness PQAR ✓ 7-28-01

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 43.8

Witness PQAR ✓ 7-28-01

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR ✓ 7-28-01

6.0.12 Continue increase load until failure occurs.:

Witness PQAR ✓ 7-28-01

7-28-04

6.0.13 Verify load and instrumentation.

Verify PQAR 7-28-01

X 6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 330.3
Failure location:
N/A swage
6¼ - T inches from cable end
N/A other

Note: Load Rate 0.8 IN/MIN Per Telecon

Verify PQAR 7-28-01

6.0.16 Photograph set-up. 7-28-01

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 7-28-01

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

7-28-04

Attachment 10

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 7-28-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 5369 Elv-10

Verify PQAR 7-28-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 7-28-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR 7-28-04

6.0.5 Photograph set-up. 7-28-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR 7-28-04

X 6.0.7 Begin video. NA

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

Verify PQAR 7-28-04

6.0.9 Document temperature of test article. 1254

Witness PQAR 7-28-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 43.8

Witness PQAR 7-28-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning.

Verify PQAR 7-28-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 7-28-04

6.0.13 Verify load and instrumentation.

Verify PQAR M NASA 38Q USA 4 7-28-04

X 6.0.14 Stop video. NA

6.0.15 Document load and location of failure:
Failure load 337.8
Failure location: _____ swage
5 3/4 - T inches from cable end
_____ other

Note: Load Rate 0.8 in/min per Telecon

Verify PQAR PQAR USA 4 7-28-04
PQAR USA 4 M NASA 38Q 7-28-04

6.0.16 Photograph set-up.

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR M NASA 38Q PQAR USA 4 7-28-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

PQAR USA 4 M NASA 38Q 7-28-04

ATTACHMENT #1

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 38Q

Verify PQAR POAR USA 4 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 071081 RT-1

POAR USA 4

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 38Q

Verify PQAR POAR USA 4 8-6-04

~~*~~ 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable. N/A

Verify PQAR N/A

6.0.5 Photograph set-up.

M NASA 38Q 8-6-04

~~*~~ 6.0.6 Install furnace and heat to 1250F (HT tests only). N/A

Verify PQAR N/A

6.0.7 Begin video.

M NASA 38Q 8-6-04

~~*~~ 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only). N/A

Verify PQAR N/A

6.0.9 Document temperature of test article. 70°F

POAR USA 4

Witness PQAR 8-6-04

~~6.0.10~~ Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

M NASA 38Q 8-6-04

Witness PQAR POAR USA 4

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 46 lbs

M NASA 38Q

Verify PQAR POAR USA 4 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR POAR USA 4 8-6-04

M NASA 38Q

POAR USA 4 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR M NASA 38Q 8-6-04

6.0.14 Stop video. PQAR USA 4 8-6-04

M NASA 38Q

6.0.15 Document load and location of failure:
Failure load 1956.8
Failure location:
N/A swage
7 1/8" – T inches from cable end
N/A other

Verify PQAR PQAR USA 4 8-6-04

6.0.16 Photograph set-up. M NASA 38Q

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. M NASA 38Q 8-6-04

Verify PQAR PQAR USA 4

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

PQAR USA 4 M NASA 38Q 8-6-04

Attachment #2

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: Lot 071081 RT-2

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable. 8-6-04 SP N/A

Verify PQAR N/A 8-6-04

6.0.5 Photograph set-up. 8-6-04

*6.0.6 Install furnace and heat to 1250F (HT tests only). N/A

Verify PQAR N/A 8-6-04

6.0.7 Begin video. 8-6-04

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only): N/A

Verify PQAR N/A 8-6-04

6.0.9 Document temperature of test article. 70°F

Witness PQAR 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 8-6-04

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.6

Verify PQAR 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 8-6-04

8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video. 8-6-04

6.0.15 Document load and location of failure:
Failure load 1954.4
Failure location:
N/A swage
3 3/4" - T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

ATTACHMENT #3

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 041081 RT-3

Verify PQAR PQAR USA 4 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

N/A 8-6-04

Verify PQAR N/A

6.0.5 Photograph set-up.

M NASA 38Q 8-6-04

*6.0.6 Install furnace and heat to 1250F (HT tests only).

N/A

Verify PQAR N/A 8-6-04

6.0.7 Begin video.

M NASA 38Q 8-6-04

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

N/A

Verify PQAR N/A 8-6-04

6.0.9 Document temperature of test article. 71°F

PQAR USA 4

Witness PQAR 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

M NASA 38Q 8-6-04

Witness PQAR PQAR USA 4 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.6 lbs

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 8-6-04

PQAR USA 4 M NASA 38Q 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR ____ 8-6-04

6.0.14 Stop video. 8-6-04

6.0.15 Document load and location of failure:
Failure load 1891.5 (1853.5) second Peak Load
Failure location:
N/A swage
3 3/4" - T inches from cable end
N/A other

Verify PQAR ____ 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR ____ 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment 4

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT [redacted] 071081 RT-4

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

N/A

Verify PQAR N/A 8-6-04

6.0.5 Photograph set-up. 8-6-04

*6.0.6 Install furnace and heat to 1250F (HT tests only).

N/A

Verify PQAR N/A 8-6-04

6.0.7 Begin video. 8-6-04

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only).

N/A

Verify PQAR N/A 8-6-04

6.0.9 Document temperature of test article. 70°F

Witness PQAR 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 8-6-04

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 44.7 lbs

Verify PQAR 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 8-6-04

8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video. 8-6-04

6.0.15 Document load and location of failure:
Failure load 1925.6
Failure location: Inside Top swage
N/A inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment # 5

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR — M NASA 38Q — 8-6-04 — PQAR USA 4

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 071081 RT-5

Verify PQAR — PQAR USA 4 — 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR — M NASA 38Q — 8-6-04 — PQAR USA 4

* 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR — N/A — N/A — 8-6-04

6.0.5 Photograph set-up. — M NASA 38Q — 8-6-04

* 6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR — N/A — N/A — 8-6-04

6.0.7 Begin video. — M NASA 38Q — 8-6-04

* 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR — N/A — N/A — 8-6-04

6.0.9 Document temperature of test article. 71°F

Witness PQAR — PQAR USA 4 — 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR — M NASA 38Q — 8-6-04 — PQAR USA 4 — 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.9 lbs

Verify PQAR — M NASA 38Q — 8-6-04 — PQAR USA 4

6.0.12 Continue increase load until failure occurs.:

Witness PQAR — PQAR USA 4 — 8-6-04

PQAR USA 4 — M NASA 38Q — 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video.

8-6-04

6.0.15 Document load and location of failure:
Failure load 1539.8
Failure location: Inside Top swage
N/A inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up.

8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #6

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 071081 E16 - 6

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR 8-6-04

6.0.5 Photograph set-up. 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR 8-6-04

6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR 8-6-04

6.0.9 Document temperature of test article. 1251°F

Witness PQAR 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 46.2 lbs

Verify PQAR 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 8-6-04

8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR ✓ 8-6-04

X 6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 374.7
Failure location:
N/A swage
6.0"-T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.
Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #7

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 38Q 8-6-04

Verify PQAR PQAR USA 4

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 071081 Elv-7

PQAR USA 4

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.5 Photograph set-up.

M NASA 38Q 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

*6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.9 Document temperature of test article. 1254°F

PQAR USA 4

Witness PQAR 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

M NASA 38Q 8-6-04

Witness PQAR PQAR USA 4 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 43,0 lbs

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 8-6-04

PQAR USA 4 M NASA 38Q

6.0.13 Verify load and instrumentation.

Verify PQAR ____ 8-6-04

* 6.0.14 Stop video. N/A 8-6-04

6.0.15 Document load and location of failure:
Failure load 383.2
Failure location: N/A swage
6.0" - T inches from cable end
N/A other

Verify PQAR ____ 8-6-04

6.0.16 Photograph set-up. ____ 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR ____ 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #8

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 071681 ELV-8

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR 8-6-04

6.0.5 Photograph set-up. 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only). 8-6-04

*6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR 8-6-04

6.0.9 Document temperature of test article. 1259 °F

Witness PQAR 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 8-6-04

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 46 lbs

Verify PQAR 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 8-6-04

8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

*6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 388.8 lbs
Failure location:
N/A swage
6.0" T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 8-6-04
Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment # 9

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 071081 EL-9

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR 8-6-04

6.0.5 Photograph set-up. 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR 8-6-04

~~*6.0.7~~ Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR 8-6-04

6.0.9 Document temperature of test article. 1258 °F

Witness PQAR 8-6-04

~~6.0.10~~ Ramp load to approximately ~~45~~ pounds at a load rate not to exceed 5 inches per minute. 8-6-04

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 44 lbs

Verify PQAR 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 8-6-04

8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 358.0
Failure location:
N/A swage
4 3/8"-4 inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

ATTACHMENT # 10

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 071081 S/N-10

Verify PQAR PQAR USA 4 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR M NASA 38Q 8-6-04 PQAR USA 4

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.5 Photograph set-up. M NASA 38Q 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only). M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

*6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.9 Document temperature of test article. 1240°F

Witness PQAR PQAR USA 4 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. M NASA 38Q

Witness PQAR PQAR USA 4 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 43.5 lbs

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 8-6-04

8-6-04 PQAR USA 4 M NASA 38Q

6.0.13 Verify load and instrumentation.

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

*6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 361.3 lbs
Failure location:
N/A swage
4 1/8" - T inches from cable end
N/A other

Verify PQAR PQAR USA 4 8-6-04

6.0.16 Photograph set-up. M NASA 38Q 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. M NASA 38Q 8-6-04

Verify PQAR PQAR USA 4

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

PQAR USA 4 M NASA 38Q 8-6-04

attachment # 1

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR — M NASA 38Q / PQAR USA 4 — 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 RT-1

Verify PQAR — PQAR USA 4 — 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR — M NASA 38Q / PQAR USA 4 — 8-6-04

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR — N/A / N/A — 8-6-04

6.0.5 Photograph set-up. — M NASA 38Q — 8-6-04

*6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR — N/A / N/A — 8-6-04

6.0.7 Begin video. — M NASA 38Q — 8-6-04

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR — N/A / N/A — 8-6-04

6.0.9 Document temperature of test article. 71 °F

Witness PQAR — PQAR USA 4 — 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR — M NASA 38Q / PQAR USA 4 — 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.8 lbs

Verify PQAR — M NASA 38Q / PQAR USA 4 — 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR — PQAR USA 4 — 8-6-04

PQAR USA 4 / M NASA 38Q 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR ✓ 8-6-04

6.0.14 Stop video. ✓ 8-6-04

6.0.15 Document load and location of failure:
Failure load 1900.3
Failure location:
Inside Top swage
N/A inches from cable end
N/A other

Verify PQAR ✓ 8-6-04

6.0.16 Photograph set-up. ✓ 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. ✓ 8-6-04

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

ATTACHMENT #2

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR

M NASA 38Q ✓ 8-6-04

PQAR USA 4

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 RT-2

Verify PQAR PQAR USA 4 ✓ 8-6-0

M NASA 38Q

~~6.0.3~~ Mount the Restraint Cable into the fixture. ✓ 8-6-0

Verify PQAR PQAR USA 4

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable. N/A

Verify PQAR N/A ✓ 8-6-0

M NASA 38Q

6.0.5 Photograph set-up. ✓ 8-6-0

*6.0.6 Install furnace and heat to 1250F (HT tests only). N/A

Verify PQAR N/A

M NASA 38Q ✓ 8-6-04

6.0.7 Begin video.

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only): N/A

Verify PQAR N/A

6.0.9 Document temperature of test article. 71°F

Witness PQAR PQAR USA 4 ✓ 8-6-04

M NASA 38Q

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. ✓ 8-6-0

Witness PQAR PQAR USA 4

M NASA 38Q

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.4 lbs

Verify PQAR PQAR USA 4 ✓ 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 ✓ 8-6-04

8-6-04 PQAR USA 4 M NASA 38Q

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video. 8-6-04

6.0.15 Document load and location of failure: Third ~~Second~~ Peak Load
Failure load 1863.3 (1969.2)
Failure location: N/A swage
7⅛" - T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 8-6-0

Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #3

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

M NASA 38Q ✓

Verify PQAR PQAR USA 4 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 RT-3

Verify PQAR PQAR USA 4 8-6-04

M NASA 38Q

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR PQAR USA 4 8-6-04

* 6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR N/A N/A 8-6-04

M NASA 38Q

6.0.5 Photograph set-up. 8-6-04

* 6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR N/A N/A 8-6-04

M NASA 38Q

6.0.7 Begin video. 8-6-04

* 6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR N/A N/A

6.0.9 Document temperature of test article. 71°F

Witness PQAR PQAR USA 4 8-6-04

M NASA 38Q

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 8-6-04

Witness PQAR PQAR USA 4

M NASA 38Q

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 47.4

Verify PQAR PQAR USA 4 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 8-6-04

PQAR USA 4

M NASA 38Q 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04 8-6-04

6.0.14 Stop video.

6.0.15 Document load and location of failure:
Failure load 1899.4 lbf
Failure location:
N/A swage
3½"-T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 8-6-04
Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #4

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
	Date: 7/26/04	Page 6 of 9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 RT-4

Verify PQAR PQAR USA 4 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

~~*~~6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR N/A N/A 8-6-04

6.0.5 Photograph set-up.

M NASA 38Q 8-6-04

~~*~~6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR N/A N/A

6.0.7 Begin video.

M NASA 38Q 8-6-04

~~*~~6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR N/A N/A

6.0.9 Document temperature of test article. 71 °F

Witness PQAR PQAR USA 4 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

M NASA 38Q 8-6-04

Witness PQAR PQAR USA 4 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 48.6 lbs

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 8-6-04

PQAR USA 4 M NASA 38Q 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video.

6.0.15 Document load and location of failure:
Failure load 2008.5
Failure location:
N/A swage
35"-T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #5

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR — M NASA 38Q ✓ — PQAR USA 4 — 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 RT-5

Verify PQAR — PQAR USA 4 — 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR — M NASA 38Q — 8-6-04 — PQAR USA 4

*6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR — N/A — N/A — M NASA 38Q — 8-6-04

6.0.5 Photograph set-up.

*6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR — N/A — N/A — M NASA 38Q — 8-6-04

6.0.7 Begin video.

*6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR — N/A — N/A

6.0.9 Document temperature of test article. 71°F

Witness PQAR — PQAR USA 4 — 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute.

Witness PQAR — M NASA 38Q — 8-6-04 — PQAR USA 4

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 48.1 165

Verify PQAR — M NASA 38Q — 8-6-04 — PQAR USA 4

6.0.12 Continue increase load until failure occurs.:

Witness PQAR — PQAR USA 4 — 8-6-04

M NASA 38Q — PQAR USA 4 — 8-10-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video. 8-6-04

6.0.15 Document load and location of failure:
Failure load 19816 lbs
Failure location:
N/A swage
3¼-T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. 8-6-04
Verify PQAR

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
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Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #6

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR ✓ 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 - E/L-6

Verify PQAR ✓ 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR ✓ 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR ✓ 8-6-04

6.0.5 Photograph set-up. ✓ 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR ✓ 8-6-04

~~*~~6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR ✓ 8-6-04

6.0.9 Document temperature of test article. 1253

Witness PQAR 8-6-04

6.0.10 Ramp load to approximately ~~45~~ pounds at a load rate not to exceed ~~5~~ inches per minute.

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 44.7

Verify PQAR ✓ 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 387.8 lbs
Failure location:
N/A swage
5.0"-T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.
Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #7

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 Elv-7

Verify PQAR PQAR USA 4 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.5 Photograph set-up. M NASA 38Q 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

~~6.0.7~~ Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.9 Document temperature of test article. 1259 °F

Witness PQAR PQAR USA 4 8-6-04

~~6.0.10~~ Ramp load to approximately ~~45~~ pounds at a load rate not to exceed ~~5~~ inches per minute.

Witness PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 49.5

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 8-6-04

PQAR USA 4 M NASA

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

*6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 370.6 lbs
Failure location:
N/A swage
5¼ ± T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
Cary Cox (321) 867-1757
Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

Attachment #8

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104936 E1-8

Verify PQAR PQAR USA 4 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR M NASA 38Q PQAR USA 4 8-6-04

6.0.5 Photograph set-up. M NASA 38Q 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only). M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

*6.0.7 Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only): M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.9 Document temperature of test article. 1251 °F

Witness PQAR PQAR USA 4 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. M NASA 38Q 8-6-04

Witness PQAR PQAR USA 4 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 44.1 M NASA 38Q 8-6-04

Verify PQAR PQAR USA 4

6.0.12 Continue increase load until failure occurs.:

Witness PQAR PQAR USA 4 8-6-04

PQAR USA 4 M NASA 38Q 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

*6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 399.8 lbs
Failure location:
N/A swage
5½" T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
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Pat Roberts (321) 867-1757
Mark Hill (256) 544-4327 or Brian Pung (256) 544-9346

8-6-04

Attachment #9

6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR ✓ 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104236 El-9

Verify PQAR ✓ 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR ✓ 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR ✓ 8-6-04

6.0.5 Photograph set-up. ✓ 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR ✓ 8-6-04

~~6.0.7~~ Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR ✓ 8-6-04

6.0.9 Document temperature of test article. 1250 °F

Witness PQAR ✓ 8-6-04

6.0.10 Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. ✓ 8-6-04

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 43.7 8-6-04

Verify PQAR

6.0.12 Continue increase load until failure occurs.: ✓ 8-6-04

Witness PQAR

6.0.13 Verify load and instrumentation.

Verify PQAR PQAR USA 4 8-6-04

~~6~~6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 392.7 lbs
Failure location:
N/A swage
5 3/4" - T inches from cable end
N/A other

Verify PQAR PQAR USA 4 8-6-04

6.0.16 Photograph set-up. M NASA 38Q 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify. M NASA 38Q

Verify PQAR PQAR USA 4 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
Richard Knochelmann (321) 867-9813 or Chris Epler (321) 867-9309
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Pat Roberts (321) 867-1757
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PQAR USA 4 M NASA 38Q 8-6-04

Attachment # 10

ED33 / MECHANICAL METALLURGY AND CORROSION TEAM		
SRB Diagonal Strut Restraint Cable Assembly QUALIFICATION TEST	SRB-QUAL-04-0064	Revision: Basic
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6.0 TEST OPERATION

6.0.1 Verify calibration is current for all calibrated test equipment in accordance with ED33-WI-012 Mechanical Testing Calibration and Verification Procedures

Verify PQAR 8-6-04

6.0.2 Note serial number or other identification for the Restraint Cable in test: LOT 104936 Elv -10

Verify PQAR 8-6-04

6.0.3 Mount the Restraint Cable into the fixture.

Verify PQAR 8-6-04

6.0.4 Apply three thermocouples, one at the top, middle and bottom of the Restraint Cable.

Verify PQAR 8-6-04

6.0.5 Photograph set-up. 8-6-04

6.0.6 Install furnace and heat to 1250F (HT tests only).

Verify PQAR 8-6-04

~~6.0.7~~ Begin video. N/A

6.0.8 Verify all thermocouples read 1250F +/- 10 degrees (HT tests only):

Verify PQAR 8-6-04

6.0.9 Document temperature of test article. 1251 °F

Witness PQAR 8-6-04

~~6.0.10~~ Ramp load to approximately 45 pounds at a load rate not to exceed 5 inches per minute. 8-6-04

Witness PQAR 8-6-04

6.0.11 Verify load is at approximately 45 pounds and all instrumentation is functioning. 42.7 lbs

Verify PQAR 8-6-04

6.0.12 Continue increase load until failure occurs.:

Witness PQAR 8-6-04

6.0.13 Verify load and instrumentation.

Verify PQAR 8-6-04

*6.0.14 Stop video. N/A

6.0.15 Document load and location of failure:
Failure load 402.4 lbs
Failure location:
N/A swage
5⅛" - T inches from cable end
N/A other

Verify PQAR 8-6-04

6.0.16 Photograph set-up. 8-6-04

6.0.17 Place broken Restraint Cable debris in Ziploc bag and identify.

Verify PQAR 8-6-04

6.0.18 IF any anomaly or test failure occurs below the expected minimum values, contact the following within 24 hours:
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8-6-04

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 2006	Technical Memorandum

4. TITLE AND SUBTITLE

Qualification Testing of Solid Rocket Booster Diagonal Strut Restraint Cable Assembly Part Number 10176–0031–102/103

5. FUNDING NUMBERS

6. AUTHORS

T.W. Malone

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

8. PERFORMING ORGANIZATION REPORT NUMBER

M–1172

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Aeronautics and Space Administration
Washington, DC 20546–0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

NASA/TM—2006–214603

11. SUPPLEMENTARY NOTES

Prepared by the Materials and Processes Laboratory Engineering Directorate
Supplemental DVD containing video footage of tests is available upon request

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Unclassified-Unlimited
Subject Category 26
Availability: NASA CASI 301–621–0390

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This Technical Memorandum presents qualification test results for solid rocket booster diagonal strut restraint cable part number 101276–00313–102/103. During flight this assembly is exposed to a range of temperatures. MIL–W–83420 shows the breaking strength of the cable as 798 kg (1,760 lb) at room temperature but does not define cable strength at the maximum temperature to which the cable is exposed during the first 2 min of flight; 669 °C (1,236 °F). The cable, which can be built from different corrosion resistant steel alloys, may also vary in its chemical, physical, and mechanical properties at temperature. Negative margins of safety were produced by analysis of the cable at temperature using standard knockdown factors. However, MSFC–HDBK–5 allows the use of a less conservative safety factor of 1.4 and knockdown factors verified by testing. Test results allowed a calculated knockdown factor of 0.1892 to be determined for the restraint cables, which provides a minimum breaking strength of 151 kg (333 lb) at 677 °C (1,250 °F) when combined with the minimum breaking strength of 0.317-cm (0.125- or 1/8-in) diameter, type 1 composition rope.

14. SUBJECT TERMS

SRB diagonal strut restraint cable assembly, materials tension testing, MSFC–HDBK–5, MIL–W–83420

15. NUMBER OF PAGES

100

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

National Aeronautics and
Space Administration
IS20
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Marshall Space Flight Center, Alabama
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